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PLANNING OF RESEARCH

EARLY in 1944, the Government of India constituted a Research Planning Committee in accordance with the resolution of the Governing Body of the Council of Scientific and Industrial Research, to survey the existing facilities for scientific and industrial research in India and to "report on necessary measures of co-ordination, control, direction and development of such research by various agencies and also on other steps necessary for the planning of research in post-war India". The Committee's work was interrupted for a short time due to the absence of the Chairman in the U.S.A. on official duties and in the final stages, the Committee was denied the benefit of advice and collaboration of three members, Sir S. S. Bhatnagar, Sir J. C. Ghosh and Prof. S. K. Mitra, on account of their visit to England and America as members of the Delegation of Indian Scientists.

The Committee circularised two sets of questionnaire—one to the various universities, research institutes and Government departments interested in scientific and industrial research, and the other to industrial firms and chambers of commerce. To obtain a first-hand knowledge of the existing facilities for research, the Committee visited important centres of scientific activity and had personal discussions with scientific workers, university representatives and leaders of industry and commerce at some of these centres. The facts obtained through these channels have been critically appraised and presented in a comprehensive document* which also includes the recommendations of the Committee with regard to post-war planning of pure and applied research.

The Committee in its report records that the present research activity in India does not represent even the bare minimum whether judged by international standards or by the actual requirements of the country in her present state of industrial development. The need for research is felt not only for facilitating an adjustment to post-war conditions but also for promoting the general cause of industrialisation at a time which will be rendered much more difficult by the forces of international competition. The capacity of Indian industry to withstand international competition will depend materially on its vision and its readiness to implement the latest results of research in a continual effort for improving its productive efficiency by economy in the use of raw materials, utilisation of by-products, reduced power cost, and so on. Research will also play a decisive part in the development of new industries for which the opportunities remain imperfectly explored.

Industrial research, in this country, is still in its infancy. Besides the lack of an effective link between our principal research institutions and the industrial interests concerned, a further obstacle to the inception of a suitable research atmosphere has been created by the fact that while Industry constitutes a Provincial subject, it is beyond the resources of most of the provinces to build up adequate research organisations for catering to the needs of local industries. The institutes set up by the Government of India have remained much too centralised for meeting the various regional needs. Moreover, industry, with some rare exceptions, has not become research-minded. Nor there is an effective *liaison* between industry and the research organisations.

If scientific and industrial research is to make any headway in India in the immediate future, the Committee feels that Government must take the initiative in setting up a suitable machinery for the development of research along sound lines, strengthen the science departments of universities and existing research institutions and bring about an effective co-ordination amongst all the institutions. For stimulating and directing scientific and indus-

*"Report of the Industrial Research Planning Committee, Council of Scientific and Industrial Research," 1945. Price Rs. 3.

trial research on a planned and comprehensive basis, the Committee recommends that the Government of India should forthwith set up a central research organisation to be called the National Research Council. This organisation would consist of representatives of scientists, universities, industry, labour and administration. The Hon'ble Member in charge of Planning and Development is suggested to be its *ex-officio* President. The Council, which should be an autonomous body, should have a total membership of 60 made up of 20 scientists elected by the universities and recognised scientific associations, 15 members elected by recognised chambers of commerce and associations of manufacturers, five members elected by recognised trade unions and other labour organisations, and 20 members nominated by the Government of India of whom not more than 8 may be official. Of these two should represent the railway administration.

The functions of the Council will be as follows:—

(1) to organise and maintain national laboratories;
(2) to establish and maintain specialised research institutes;
(3) to stimulate pure and applied research in universities by grants-in-aid and by the institution of scholarships and fellowships;
(4) to provide for the immediate problem of the dearth of technical and research personnel by the inauguration of scholarships available in India and abroad;
(5) to stimulate and esccurage research activities by industry;
(6) to co-ordinate research activities of all the existing research institutes and departments of Government and undertake planning of research programmes on a comprehensive basis;
(7) to function as a National Trust for Patents;
(8) to set up a Board of Standards and Specifications;
(9) to function as a Clearing House, encourage deserving scientific and technical societies and foster the growth of new ones on appropriate lines.

A small executive body to be called the Research Board will be responsible for the administration of the work of the Council. The Board will be in charge of all the research laboratories and institutions set up by the National Council and directors of these institutions will be under the control of the Board. It will also maintain the closest contact with Directors of laboratories engaged in industrial research under the administration of the other departments of the Central Government. The Board will prepare comprehensive plans of research programmes and will take an active part in the establishment of research institutions by industries and distribute grants-in-aid to universities and other approved institutions with the help of the Grants Committee from funds specially allotted for the purpose.

The Committee recommends that the Council, given a bulk grant of Rs. 6 crores spread over five years, should make and carry out (i) the building and equipment of National Chemical and Physical Laboratories, (ii) the building and equipment of certain specialised research institutes; (iii) giving grants-in-aid to universities for strengthening their research organisation, and (iv) training of research personnel by the award of scholarships tenable in India and abroad.

The establishment of a National Chemical and a National Physical Laboratory is recommended each at an estimated cost of Rs. 40 lakhs. It is further recommended that in the absence of industrial research associations in India (except for jute and tea) it is necessary for the State to take the initiative for the establishment of a number of specialised laboratories for fulfilling the object. Nine new specialised institutes are recommended in the following order of priority:—

Institute of Food Technology; Metallurgical Institute; Fuel Research Institute; Glass and Silicate Research Institute; Oils and Paints Institute; Buildings and Road Institute; Leather and Tanning Institute; Industrial Fermentation Institute; and Electro-Chemical Institute.

These specialised research institutes will deal with problems of basic and specific research relating to their respective spheres. Provincial and State Research Councils may send problems for investigations to these institutes and it will be open to individual manufacturers to refer specific problems of immediate interest to industry to such laboratories on payment of scheduled fees or by the establishment of fellowships.

The Committee considers that universities constitute the foundation of all research and suggests the strengthening of scientific teaching and research work in Indian universities. As an essential part of the five-year plan, the Committee recommends that the National Research Council should make substantial grants for strengthening the scientific departments of the universities. For this purpose the Grants Committee should make a survey of science and research departments of all the Indian universities and recommend to the National Research Council a scheme of financial assistance to the latter. Out of the bulk grant of Rs. 6 crores, the Committee says, a sum of about Rs. 2 crores should be set aside for giving grants-in-aid to the 19 universities. Further, adequate engineering research sections should be in contact with the engineering colleges. Teachers in such colleges should be in contact with the engineering industries.

To man the various laboratories proposed to be set up and to keep alive the research work in the country the Committee recommends that 700 research workers should be trained in five years involving an estimated total expenditure of about Rs. 50 lakhs: Rs. 27 lakhs for foreign scholarships and Rs. 23 lakhs for Indian scholarships. Industries should be encouraged to set up their own research associations on corporate basis by exemption of research expenditure of firms from income-tax assessment.

A network of corresponding research organisations should be set up in Provinces and major States. It is recommended that research councils on the model of the National Research Council composed of the representatives of

scientists, industry and administration, should be set up in all the Provinces and major States.

A suitable method for the exploitation of patents in respect of inventions made at either the national laboratories or universities and other research organisations should be evolved. A National Trust of Patents should be set up for the purpose of holding and exploiting all patents resulting from research financed by Government and those dedicated by individual scientists and by institutions, supported either by public funds or private endowments.

The institution of a Board of Standards for drawing up Indian standard specifications and the establishment of a technological institute on the lines of M.I.T. are recommended.

The Committee emphasises that research can yield its best results only when it is backed by a comprehensive industrial plan. This will not only inspire enthusiasm among research workers but will serve the practical purpose of indicating an order of priority in the various lines of investigation. The Committee accordingly recommends that the National Research Council must work in close co-operation with the department of Industrial Planning so that industry and research will each stimulate the other.

The Committee further emphasises the organic relationship between the different categories of research, *viz.*, agricultural, medical and industrial, and welcomes the constitution of the Scientific Consultative Committee in the Department of Planning and Development as a body expected to secure the necessary co-ordination at a high level. The Committee, however, considers it necessary to examine the possibility of bringing all the research activities of the various Government departments under the administrative control of the Member for Planning and Development.

RESINATED FABRIC LAMINATES

THE development of jute fabric-shellac laminates by the Indian Jute Mills' Association, an account of which appeared in this *Journal* last month (August 1945, pp. 202-03), provides an appropriate opportunity for reviewing briefly the basic work carried out in India on the subject of resin-impregnated fabrics which find numerous industrial applications. The work dates back to 1926, when successful investigations on a laboratory scale were carried out in the *University Chemical Laboratories, Lahore*. The commercial possibilities of the products attracted wide attention, and at least two Indian industrialists, one from Calcutta, and another from Cawnpore, came forward to finance the development work on fabric-shellac laminates, particularly for constructional purposes and for the production of containers. When the *Board of Scientific and Industrial Research* was inaugurated in 1940, the problem of resinated fabrics was taken up once again for detailed investigation. Metal containers were in short supply and there was an urgency for finding substitute materials. Resinated laminates of textile materials and paper suggested themselves as suitable substitutes, providing wide scope for the development of a large range of containers. A considerable amount of basic work, both on the methods of spreading resin on fabrics and on processing them, was carried out. Successful processes were developed for the manufacture of resinated laminates both of fabrics and of paper, in the laboratories of the *Board* (*cf.* Indian Patent Nos. 28277 and 28281) and handed over to industry and army for exploitation and development.

The application of shellac or other resins to fabrics, which is the primary process in the production of this class of materials, can be carried out in one or the other of the following ways: (1) dusting shellac or applying molten lac without the use of any solvent, but using only wetting agents, and passing the treated material between hot rollers to ensure uniform spreading of the resin, (2) impregnating with aqueous dispensions of powdered shellac, and (3) impregnating solutions of shellac, in solvents selected for their easy availability or cheapness or processing advantage. The resin coated materials are further processed to obtain laminates. They can be passed between hot rollers or compressed in hydraulic presses to obtain products of any desired compactness and finish. A variety of samples were prepared in the laboratories of the *Board of Scientific and Industrial Research* by employing various methods of spreading shellac and of processing the treated fabrics. For the production of unburstable containers (Indian Patent No. 28247) solutions of shellac in alcohol or ammonia were employed, and for jettison tanks, required by the U.S.A. Air Force, either dispersions of shellac in water, or molten lac with extenders or wetting agents, were preferred. It is obvious that for the production of laminates on a commercial scale, one or the other of the methods investigated in the laboratories of the *Board of Scientific and Industrial Research* or modifications thereof, will have to be employed. Wartime successes have been determined largely by the availability of processing materials and manufacturing equipment, and recourse had to be taken often to alternate processes as expedients, such as the *one* developed by the Indian Jute Mills' Association, for securing immediate results. As the emergency conditions, do not obtain any longer, future developments will be determined largely by the quality of the products and the efficiency of the processing techniques. The laminated boards have already found use in the production of a large number of useful products (*cf.* Indian Patent No. 30680). We are glad to learn that the processes developed by the scientists in their research laboratories are being increasingly utilized by industry. This is to be welcomed. History teaches us that every development of an enduring character originated in a research laboratory. It is appropriate that the *Council of Scientific and Industrial Research* has been pursuing an enlightened and liberal policy with regard to the processes developed in its research laboratories, which aims at providing all possible assistance to industry. Further applications of resinated laminates envisaged by the work of the *Council* will be watched with keen interest.

ALTERNATE MEDIA FOR LARGE-SCALE REARING OF THE RICE MOTH—*CORCYRA CEPHALONICA* ST., IN THE WORK OF MASS-PRODUCTION OF THE EGG-PARASITE *TRICHOGRAMMA MINUTUM* R.

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IN the United States of America, West Indies and other countries, wheat is used for large-scale rearing of the Angumois moth (*Stitotroga cerealella*, Ol) on the eggs of which the parasite *Trichogramma evanescens* Westw. is multiplied in connection with the biological control of the sugarcane stem-borer (*Diatræa saccharalis* F.). For the mass production of *Trichogramma minutum* R.—the local egg-parasite of the cane-borer, *Argyria sticticraspis* Hmp., Jowar (*Andropogon sorghum*) was the medium selected as the most suited for mass rearing of the Rice moth *Corcyra cephalonica* St. on the eggs of which it was decided to breed the egg-parasite (*Trichogramma minutum* R.).

In 1943, however, owing to the shortage of foodgrains in the country and the consequent difficulty in obtaining adequate supplies of jowar for this purpose, it became necessary to find alternate materials which would be acceptable to the Rice moth, inexpensive and abundant. Mixtures of tapioca and wheat and rice brans were tried as possible alternatives to jowar. Tapioca alone, however, not being considered conducive to the proper development of the moths (as was later shown by actual tests) it was decided upon to mix it with a sufficient quantity of some material that would make up for the protein deficiency in tapioca. The Agricultural Chemist suggested an admixture of about 20 per cent. bran (of wheat or rice) with tapioca. Further, previous work with jowar in this laboratory having shown the value of incorporating yeast in the medium and as had already been definitely shown by Swamy and Sreenivasaya,[1,2] that *Corcyra cephalonica* St., fed on a diet deprived of its vitamin B_1, showed a poor growth, etc., it was thought advisable to enrich the mixture of tapioca and bran with some yeast. A quantity of 2 per cent. yeast was considered adequate for the purpose by the Agricultural Chemist. A mixture, namely, of 79 per cent. tapioca, 19 per cent. bran and 2 per cent. yeast was, therefore, finally employed in the tests with tapioca discussed here.

These trials were conducted in large-sized petri-dishes each of which 10 gm. of material was put in and 100 freshly-laid eggs of *Corcyra* were sprinkled on the surface and the dishes covered with tight-fitting wire-gauze covers. These dishes (ten in number) were enclosed in a specially-devised wooden cupboard in which small dishes containing water (replenished daily) were kept in order to keep the requisite humidity. This work extended from April to June 1943 when the average internal temperature of the rearing cupboard was 77·1° F. (average room temperature = 78·0° F.); the range of variation between the cupboard and room temperatures was, therefore, slight, not more than ± 1·0° F. on any day.

Tests were conducted with tapioca alone and with yeast, tapioca in combination with wheat bran and rice bran (with and without yeast) and with jowar and also with wheat bran and rice bran. Jowar was set up separately as a control for assessing the relative usefulness of tapioca, wheat bran and rice bran. The following combinations with tapioca were set up:

TABLE I

1.	Tapioca 98 gm.	+	Yeast 2 gm.	
2.	do. 80 ,,	+	Jowar 20 ,,	
3.	do. do.	+	Rice bran 20 gm.	
4.	do 79 ,,	+	Rice bran 19 ,,	+ yeast 2
5	do. 80 ,,	+	Wheat bran 20 ,,	
6.	do. 79 ,,	+	,, 19 ,,	+ yeast 2 gm.

Results of rearing the Rice moth in different media

No.	Nature of medium	Period of Development of first moth (days)	Percentage of emergence	Emergence period (days)	Size of moths (Average)				Fecundity (No. of eggs per moth)		Longevity (in days)		
					Length	Wing-Exp.	Length	Wing-Exp.	Ave.		Paired	Unpaired	
					mm.	mm.	mm.	mm.					
1	Tapioca	No Emergence											
2	Tapioca + Yeast	do.											
3	Tapioca + Rice bran	43	25	42	8·0	17·5	7·3	14·4	152	10	11·6	12	15
4	Tapioca + Rice bran + Yeast	44	33	41	8·2	18·5	6·3	13·3	149	8	12·5	8·3	13
5	Tapioca + Wheat bran	38	54	48	8·3	18·3	7·2	14·6	129	8·3	14·3	8·0	14
6	Tapioca + Wheat bran + Yeast	42	61	36	8·7	18·1	7·6	15·0	192	9·2	12·6	9	15
7	Tapioca + Jowar	40	37	42	8·6	19·0	7·5	15·0	171	8	9·	8·2	15
8	Ricebran	41	40	42	8·4	19·1	7·4	15·8	133	10·3	13·7	9	17
9	Wheat bran	28	100	34	9·5	20·6	8·5	18·0	158	5·3	5·5	Not noted	
10	Jowar (Control)	39	58	42	8·7	19·8	7·9	15·3	179	8	12	9	15

In each medium the period of development (of the first moth to emerge), percentage of emergence, the total emergence period (from the first to the last moth), average size, longevity, and fecundity of the emerging moths were worked out and are discussed briefly below. The table records the data.

(1) *Period of development.*—Varied from 28 days in wheat bran to 44 days in tapioca + rice bran + yeast (jowar 39 days). There was no emergence of moths at all from tapioca or tapioca + yeast.

(2) *Percentage of emergence.*—Ranged from 25 in tapioca + rice bran to 100 in wheat bran (jowar 58).

(3) *Emergence period.*—Ranged from 34 days in wheat bran to 48 days in tapioca + wheat bran (jola 42 days). The development of *Corcyra* is known to be irregular and consequently the emergence period fairly long, about six weeks in jowar.

(4) *Average size of moths.*—Moths emerging from tapioca + rice bran were the smallest of the series, and those from wheat bran, the biggest, actual measurements being as follows:

TABLE II

Medium	Female		Male	
	Length	Wing-Exp.	Length	Wing-Exp.
Tapioca + Rice bran	8·0 mm.	17·5 mm.	7·3 mm.	14·4 mm.
Wheat bran	9·5 ,,	20·6 ,,	8·5 ,,	18·0 ,,
Jowar	8·7 ,,	19·8 ,,	7·9 ,,	15·3 ,,

(1) *Longevity.*—It was observed that the male moth generally lived longer than the female, and that the mated moth (male or female) had a shorter span of life than an unmated moth of the same sex; males, some of which confined singly in tubes lived quite long, up to 34 days in one case.

(2) *Fecundity.*—In every medium 6 pairs of moths (male and female moths of the same pair emerged on the same day) were mated and each pair was confined in a specially constructed cylindrical oviposition cage having a wire-mesh bottom fitted up in the middle, and with a wire-mesh lid. The cage with the two moths enclosed inside was placed upright in a petri-dish till the death of the female moth, and the eggs laid on each day was recorded. Generally, the bigger female moths were found to lay more eggs than the smaller ones. The highest average number of eggs per female moth is 192·6 in tapioca + wheat bran + yeast, and the lowest average is 129 in tapioca + wheat bran (jowar 179). The largest number of eggs laid by a single female moth in the entire series was 374 in tapioca + wheat bran + yeast.

The relative suitability of the different media for *Corcyra* rearing may be stated as follows:—

(1) *Wheat bran.*—In this material the total developmental period of the entire brood (total of columns 3 and 5 of the table) was the shortest (62 days) and the rate of emergence the highest (100 per cent.) of the whole series; this substantial reduction of two to three weeks in the developmental period compared to other media provides an extra generation of moths for every three generations produced which is a decided advantage in continuous and large-scale rearing. The moths emerging from it were the biggest in size with a fairly high fecundity.

(2) *Tapioca + wheat bran + yeast* requiring 78 days for total development and giving 61 per cent. emergence came next in order being more or less parallel in this respect to jola (81 days and 58 per cent.). The moths emerging from this material, though of a medium size showed the highest egg deposition rate of the whole series, presumably due to the presence of yeast in the mixture.

(3) *Tapioca + wheat bran* is obviously a less suitable medium than the above, as it has a longer developmental period (86 days) and a lower rate of emergence (54 per cent.). The average fecundity is, however, the lowest of the entire series in striking contrast to tapioca + wheat bran + yeast.

(4) *Rice bran* (83 days and 40 per cent.), *Tapioca + Jola* (82 days and 37 per cent.), *Tapioca + Rice bran + Yeast* (85 days and 33 per cent.) and *Tapioca + Rice bran* (85 days and 25 per cent.) appear to be comparatively unfavourable media owing to the protracted development coupled with the poor emergence in them.

(5) *Tapioca* and *tapioca + yeast.*—There was no emergence of moths from these media.

In conclusion, it may be stated that while tapioca alone, or mixed with yeast is unsuited for *Corcyra* rearing (though the later instar larvæ are capable of feeding on it to some extent), mixed with bran or jola, it is capable of supporting the rice moth. (This clearly emphasises the importance of some protein material for successful development in insects.) Wheat bran is seen to be a very good medium for this work in every respect being superior even to jowar; Rice bran, on the other hand, is not a very satisfactory medium.

1. Swamy, B. G. L., and Sreenivasaya, M., "Insects as Test animals for nutritional and vitaminic studies," *Curr. Sci.*, 1939, **11**, 365. 2. —, "Studies in Insect nutrition, Symptomology of avitaminosis in *Corcyra cephalonica*, Staint, a histological study," *Curr. Sci.*, 1942, **11**, 147.

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HAFFKINE INSTITUTE*

THE Haffkine Institute, first started as a plague research laboratory, has, under the able and enlightened Directorship of Lieut.-Col. S. S. Sokhey, extended its wings and achieved spectacular progress with nearly fifty members on the rolls of the scientific staff, there are now nine departments functioning—the departments of Vaccines, Antitoxins and Sera, Pharmacology, Biochemistry, Chemotherapy, Entomology, Nutrition and Experimental Pathology, Clinical Pathology and Virus Diseases including Rabies; in addition, there is a Blood Bank. In short, all the arteries of the Medical Sciences are running here. In recent years, the sharp dividing lines between the various branches of science are gradually shading out and, the specialist must now cease to work in "splendid isolation"; he needs the help from other sciences. This is especially true of the research worker in the field of medicine. For example, Immunology is slowly getting into the folds of Chemistry; the production of vaccines and sera, instead of remaining immutable as a bacteriological art, is becoming a technology; for a theory of formation of nerve fibres, ideas from astrophysics (!) are invoked; statistics is, of course, the handmaid of medical sciences. So, with the various interrelated departments organised at the Haffkine Institute, the researchers here can easily understand each others' language. Another gratifying feature consists in the provision of facilities for the large-scale production of drugs, a circumstance which rarely obtains at other research centres in this country. The Annual Report of the Haffkine Institute for the years 1942 and 1943 which has just reached us, gives an account of the various activities.

In the budgetary turnover of the Institute, we find that in the financial years 1941-42 and 1942-1943, the total expenditure incurred is respectively Rs. 456,430 and Rs. 7,09,701 against which it has realised Rs. 5,85,705 and Rs. 6,75,496 respectively by the sales of vaccines, sera, etc. The prices of the products from the Institute have remained competitive.

The Institute has as one of its primary duties the manufacture and supply of the medical requirements of the Governments. In the two years 1942 and 1943, the Institute has supplied 6,561,441 c.c. of plague vaccine, 6,724,243 c.c. of cholera vaccine, 336,799 c.c. of T.A.B. vaccine and 2,505 c.c. of meningococcal vaccine. The recently started Serum Department, though it has not yet reached its peak activity, has already made good progress. It maintains about 150 horses under immunisation and produces tetanus, gas-gangrene and diphtheria antitoxins, and anti-dysentery, anti-plague, and antisnake venom sera, totalling 3,39,355 ampoules in the two years. The tetanus welchii, septique, œdematiens, diphtheria, dysentery (Shiga) toxins have been produced. 220 Litres of tetanus toxoid were prepared, conforming to the accepted international standards. The Anti-rabic Department has treated 7,818 cases in two years and has prepared and supplied a total of 15,947 doses of anti-rabic vaccine. The Pharmacology Department has assayed 2,600 samples in the two years; it has supplied 15,000 sulphonamide paste tubes and 8,000 occlusive dressings to the army and 3,500 litres of glucose saline to the various organisations. The Chemotherapy Department has prepared the sulphathiazole required for clinical trials in plague and has supplied an antiseptic solution to the various hospitals.

The Pathology and Biochemical sections have rendered very valuable diagnostic aid to the various hospitals and to private practitioners; nearly 30,000 specimens were examined in the two years. As a caretaker of the health of the City and Province, the Institute does diagnostic work at a very moderate cost and free diagnosis is given to all practitioners in cases of infectious diseases as diphtheria, dysentery, cerebrospinal fever, enteric fever, typhus fever, cholera and malaria.

Haffkine Institute claims the distinction of being the first in India to obtain dried blood plasma with a locally fabricated plant. The Blood Bank has processed and dried 325·59 litres of human blood plasma in the two years.

In addition to this overburdened work due to production and routine, the research activity has been maintained at a high level. There are listed in the report 23 research publications and there is also given a brief account of the research covering 22 pages. The preventive and curative aspects of bubonic plague remain the special field of research activity of this Institute. A new plague vaccine, better than the old one, has been developed. The work of the Institute on the treatment of plague with the sulfa drugs is now widely recognised. New processes for the manufacture of some important sulfa drugs, which are covered by six patents, have been evolved and new compounds of this group have been synthesised. The pharmacology of these drugs and their effects in plague, war wounds and malaria, have been investigated. The production and preservation of anti-toxins and sera have been studied as also the changes in the protein fractions of plasma of horses undergoing hyperimmunisation against tetanus. Improvements in the methods of diagnosis have been made.

This Institute also serves as training centre for the health personnel and bacteriologists. During these two years 24 Chinese doctors and 6 local public health workers received training.

In nurturing a scientific institution one item requiring great foresight and careful consideration is the continuous replenishment and modernisation of the equipment. The problems that are presented to the researchers today demand for their speedy and satisfactory solution, special instruments and apparatus, the precision and accuracy of which are being improved almost daily. This has been well appreciated by Col. Sokhey whose constant

* "Report of the Haffkine Institute for the years 1942 and 1943," by Lt.-Col. S. S. Sokhey, I.M.S., Director, 1945.

endeavour has been to furnish the Haffkine Institute with the most modern and up-to-date equipment.

The chief problems of India are poverty and pestilence. If we have to have our public health problems tackled in an effective way, each Province should organise at least one Institution; it is revealed that Russia, which has tackled her public health problems in an admirable way, has 200 Medical Research Institutions. How many India shall need can easily gauged.

SOME ABNORMAL POLLEN GRAINS OF *PINUS EXCELSA* WALL.

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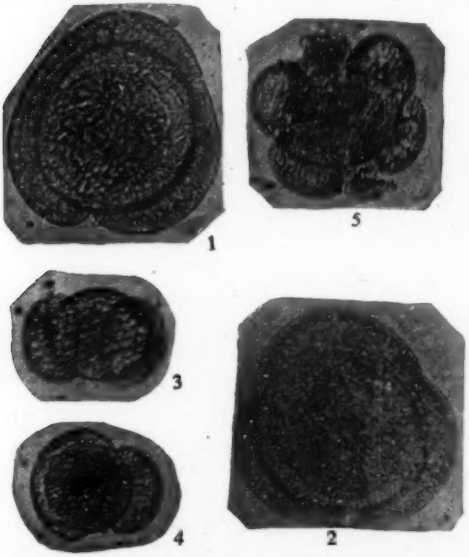
Introduction

POLLEN grains of *Pinus excelsa* Wall., as also those of other members of the Abietineæ, are normally two-winged. However, abnormal pollen grains—with one wing (encircling the body like a frill), three wings or four wings—have been infrequently observed among normal pollen of both modern and fossil material of *Pinus* and in some modern species of *Cedrus* and *Abies*. Such abnormalities are by no means confined to the Abietineæ but they are recorded in other tribes also, *e.g.*, in the Podocarpineæ the number of wings is very variable and abnormal grains have been observed in more than one species of *Podocarpus*.

One-winged pollen grains with a single bladdery exine encircling the body like a frill are recorded by Wodehouse (10, p. 266, pl. 3, fig. 8) in *Abies nobilis* and similar grains have been observed in *Cedrus Deodara, Podocarpus neriifolia* (1, pl. 5, fig. 11; and pl. 13, fig. 19) and in at least one other species of *Podocarpus* (10, pp. 219, 274). Florin (2, p. 639, text-figs. 4c, d and e) has figured two one-winged pollen grains of *P. silvestris* from postglacial deposits of Sweden and according to him "Eneroth has found that among 38,887 subfossil pollen grains of *P. silvestris* collected in the Swedish province of Norrbotten 0·04 per cent. exhibited an abnormal number (1, 3 or 4) or extension of the air sacs".



Three-winged pollen grains are recorded in more than one species of *Pinus*. Florin (2, p. 639) has recorded from the post-glacial deposits of Sweden a number of three-winged pollen grains of *P. silvestris*, and similar abnormal grains of *P. Banksiana, P. Strobus* or *P. resinosa* have been figured by Wilson and Webster (9, pl. 2, figs. 21, 22) from Vilas County bogs in the U.S.A., which are of Pleistocene age.

In modern material of *P. Khasya, P. longifolia*, and *P. Merkusii* Miss *Chatterjee* (1, pl. 14, figs. 20-22) has observed three-winged pollen grains. Four-winged pollen grains have been found in *P. silvestris* (2, *loc. cit.*), *P. Banksiana* (?), *P. strobus* or *P. resinosa* (9, figs. 25, 26).

Although abnormal pollen grains with one or four wings are already reported in other species of *Pinus*, so far as the author is aware they have not been previously observed in *Pinus excelsa*.

Description

Fig. 1 is a photomicrograph of a one-winged pollen grain, which measures 76·5 μ in diameter. The bladdery exine, which encircles the body in the form of a frill, shows a strong tendency to get transformed into two wings. Another abnormal pollen grain, illustrated in Fig. 2, shows two notches and in this specimen a tendency to get transformed into three wings is clearly seen.

Fig. 4 is a photomicrograph of another abnormal pollen in which the two bladders are of unequal size (*cf.* fig. 3, a normal pollen grain) and similar pollen grains seem to be fairly common in this species.

A four-winged pollen grain is illustrated in Fig. 5. In this specimen the four bladders are symmetrically arranged round a body, which measures 54 μ in diameter.

Discussion

It is interesting to note that a single bladdery exine, which is evidently an abnormality in modern and Pleistocene conifers, is a normal feature in ancient member of this group.

Some Palæozoic members of the Coniferales, *e.g.*, *Walchia, Lebachia* and *Ernestiodendron* (3) possessed one-winged pollen grains which do not seem to be very different from what we have described above. Pollen grains of Cordaitales were also one-winged and in

Spencerites insignis Scott (7, p. 170, figs. 78A, B and 84) and *S. membranaceous* Kubart (4, photo. 3), (ancient lycopodiaceous plants), though the pollen grains were much larger they bear a striking resemblance in external morphology to our one-winged pollen grains. In the light of the above facts one may reasonably ask: Is this abnormality merely a monstrosity of no genetical importance or is the occurrence of one-winged pollen grains in modern and Pleistocene conifers and in the Podocarpineæ a reversion to an ancient character normally found in Palæozoic conifers? An appropriate answer to this question is furnished by Florin (2, pp. 638-39), who states that "it seems probable that the presence of air-sacs in certain modern genera of the families, Pinaceæ and Podocarpaceæ, is a surviving ancient characteristic. The single air-sac originally present has only been slightly reduced since Palæozoic times, different in different genera". Wodehouse (10, pp. 219-21) agrees with Florin and states that "grains with this single encircling wing were common in the Palæozoic and appear to have been the prototypes of the winged-grained Abietineæ and Podocarpineæ".

Florin (2) further suggests that "this primitive type of pollen grain probably disappeared and the single encircling air-sac was replaced by two smaller sacs resembling those of the recent conifers of the families mentioned above". From the examination of our abnormal pollen grains it is easy to conceive how a one-winged pollen grain would have got transformed into a two-winged (fig. 1) and a three-winged type (fig. 2). Mehta (5), while supporting Virkki's (8) way of reasoning suggested that the one-winged spore could also have been the forerunner of a three-winged type and quoted Wodehouse and Florin in support of his arguments. From the present evidence it is suggested that a four-winged pollen grain may have also derived from a one-winged grain in the same way.

In the end I wish to thank Professor B. Sahni, sc.d., f.r.s., for kind suggestions and helpful criticism of this note. I am further grateful to him for kindly allowing me to examine the thesis of Mrs. Jacob (formerly Miss C. Virkki) and Miss Chatterjee and use the unpublished information in this note.

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OBITUARY

DR. HARPRASAD CHAUDHURY, Ph.D., D.Sc. (London), D.I.C.

CURRENT SCIENCE deeply regrets to record the sad and premature demise on 19th August last of Dr. Harprasad Chaudhuri, Head of the Department of University Teaching in Botany, and Director, Kashyap Research Laboratory, Punjab University.

Professor Chaudhuri was born in Calcutta in 1895 and had his school and college education in his native province of Bengal. He graduated from the Calcutta University in 1916 obtaining a distinction in Science. He took his Master's degree in Botany in 1918, and started research having been awarded a Research Scholarship in Botany. In 1920 he went abroad for higher studies and worked for three years as a research scholar under Professor V. H. Blackman, f.r.s., at the Imperial College of Science and Technology in London. After obtaining his Ph.D. and D.I.C., he returned to India and was appointed Reader in Botany at the Panjab University. On the death of Professor S. R. Kashyap in 1934 Professor Chaudhuri succeeded him as Professor of Botany which post he held until his death. In 1939 he was admitted to the D.Sc. degree of the London University. Professor Chaudhuri was the first Director of the Kashyap Research Laboratory—an institution founded by public donation to perpetuate the memory of Professor Shiv Ram Kashyap.

Professor Chaudhuri displayed his interest in Mycological research early in his career. On his return from Europe he built up a school of Mycological research in the Panjab University which had already become a centre of research in Bryology under the inspiring guidance of Professor S. R. Kashyap. Professor Chaudhuri's own contributions have enriched the field of Indian Mycology and plant pathology which were his special fields of research. Although essentially a specialist in

Fungi his interests were wide and varied and his publications cover not only his study of some individual genera of fungi like *Meliola, Verticillium, Collectotrichum, Rhinosporidium, Paradiplodia, Haplosporella*, etc., but also his observation on the coralline roots of *Cycas* and *Zamia*, the haustorium in *Cuscuta*, mycorrhiza of forest trees and the endophytic fungi in Indian liverworts. He studied the phenomenon of Saltation in *Colletotrichum biologicum* sp. nov. He published a number of papers in the "Molds of the Punjab" and was recently engaged in a study of the Smuts of the Punjab. His report on the "Citrus diseases of the Punjab" embodies the results of a five years' scheme sponsored and financed by the I.C.A.R. He has recorded in this report his observations of the various aspects of the diseases like *wither-tip, chlorosis, sooty moulds*, etc., and suggested remedial measures. According to him the *wither-tip* disease of the fruit is caused by the fungus *Collectotrichum glœosporioides* and the 'sooty mould' covering the leaves and fruits brought about by a number of saprophytic fungi like *Acrothecium lunatum* Wak., *Capnodium citri* Berk. *et* Desm., *Alternaria citri* Pierce, *Cladosporium herbarum*, *Pleospora herbarum* Rab., *Chætomium* sp., and *Aspergillus* sp. Chlorosis of the leaves on the other hand, is supposed to be more due to physiological causes than due to fungal attacks. In 1936 he suggested a scheme for enlightening the people of the country on the nature and causes of plant diseases and the methods of controlling and eradicating them. He and his collaborators have in several publications enhanced our knowledge of soil, fungi, mycorrhiza, bacterial and fungal diseases of plants and the physiology and ecology of fungi. As director of the Kashyap Research Laboratory he guided research in various branches of Botany, like Cytology, Bryology, Bacteriology and Morphology. In collaboration with Sir John Farmer he published for use in Indian Universities a book entitled *A Practical Introduction to the Study of Indian Botany!*

Professor Chaudhuri was a familiar figure at almost all the sessions of the Indian Science Congress which he regularly attended—often with his contingent of students. He presided over the Botany Section of the Indian Science Congress in 1932 and was the President of the Indian Botanical Society in 1941. He was a foundation member of the National Institute of Sciences of India. He represented India at the Twelfth International Horticultural Congress at Berlin in 1938 and presided over the Tropical Section at the same Congress.

A man of active habits and a lover of outdoor life, Professor Chaudhuri was immensely fond of field botany and organised long excursions into the Himalayan regions and conducted regular classes there during the summer months.

He was free and outspoken in his expression and was genial by temperament. He was popular amongst his friends, colleagues and students. He was married in 1919 and was fifty at the time of his death. His premature demise has deprived India of one of her leading Mycologists and an able professor.

A. R. R.

SATYENDRA NATH CHAKRAVARTI

D.Phil. (Oxon.), D.Sc. (Oxon.), F.I.C., F.A.Sc., F.N.I.

THE news of the sudden death of Dr. S. N. Chakravarti at the age of forty-five under tragic circumstances has come as a shock to his students, colleagues and friends. It is indeed a cruel irony of fate that this sincere and honest scientist with high ideals and full of ambition should be pitted against circumstances from which he could think of escaping only by nipping his thin-spun life. "The paths of glory lead but to the grave."

After a brilliant school and college record, Dr. Chakravarti went to Oxford to work in the Dyson Perrins Laboratory under the late Professor W. H. Perkin Jr. as his only Indian student. After working there for two years, he took his D.PHIL. degree and returned to India in 1929 as the Reader in Chemistry and the Head of the Chemistry Department of the newly started Annamalai University at Annamalainagar. After serving this University for about seven years, he left this, much to the regret of his students and colleagues, to accept the post of the Chemical Examiner to the Government of C.P. and U.P., which he held till the time of his death.

Dr. Chakravarti was indeed an ideal teacher and his lectures, which were prepared with meticulous care and unusual sincerity, were the highlights of the Department. He had high ideals and believed that education does not consist in telling the pupils what they do not know but in making them what they were not. Since he was a born teacher, everybody who knew him regretted when he took up the post of the Chemical Examiner wherein he had to deal more with files and red tape than with flasks and chemicals and science journals.

Dr. Chakravarti was very keenly interested in research but he could not execute his plans to his full satisfaction at the University. His work includes the synthesis of a number of derivatives of tetrahydroprotoberberine, paraberine, pseudo-opianic acid, hydroxy derivatives of naphthalene, etc., and the chemical investigation of Indian Medicinal Plants. From Agra came forth papers which dealt with the methods used in the medico-legal and forensic work.

Dr. Chakravarti was a perfect gentleman in every sense of the term. He was an extremly kind and sincere man. India is badly in need of inspiring teachers like Dr. Chakravarti; yet because of strange circumstances which which are special to this country, he was driven to seek a job which had little to do with teaching and which never suited his genius.

We offer our sympathies to his wife and children whom he leaves behind.

K. G.

ON CARPEL

By B. G. L. SWAMY
(*Basavangudi, Bangalore*)

THE picture reproduced is intended to portray the three outstanding theories of the nature of the Angiospermous flower in general and its carpel in particular.

Nearly a hundred years ago, the great German poet-philosopher, J. W. von Goethe, conceived the Angiospermous flower as a modification of vegetative branch; according to him, a simple vegetative leaf with its three main vascular traces lost its colour and shape, acquired a different character and function and ultimately resulted in the sepals and petals. A similar leaf got its laminal surface reduced, the two lateral edges developed fertility, which offered a base for lodging the male fertilizing element; these structures have come to be known as stamens. Another leaf situated towards the tip of the branch upfolded; its margins got fused and after attaining fertility bore ovules which lodged the female sexual element; this transfiguration was accompanied by an elongation of the leaf-tip which has become differentiated as style and stigma, so much so this organ becomes a carpel. If we visualise a drastic reduction of the internodes between these metamorphosed leaves, we arrive at a "flower". This concept has been depicted in the picture as a climber which shows the several stages of the metamorphosis of the vegetative leaves.

There is also a much modified interpretation of the carpel, sponsored by Miss Edith R. Saunders in nineteen-twenties. The "classical", "monorphic" concept of Goethe holds that every carpel is a metamorphosed structure of a *single* leaf; but, she visualises such a carpel as a sort of compound structure consisting of a "valve" carpel and a "consolidated" carpel; this view has come to be known as "polymorphic". Miss Saunders believes that carpel polymorphism is a universal feature (even in those instances where she herself accepted monomorphism on previous occasions). Suffice it to record that this view has not met with acceptance; it has been severely criticised from several standpoints some of the significant ones being, (1) it rests on false assumptions and misinterpretations of important anatomical evidence; (2) Miss Saunders has generalised too hastily and has extended her theory to all flowering plants; (3) her contention that her polymorphic theory helps to clarify satisfactorily the various points of floral structure and organisation has, on the contrary, brought unnecessary complications into the arena; (4) some of the points "explained" by her have been invented in strange and roundabout methods so much that they have been described as "fantastic".

The most unusual example of carpel polymorphism of Miss Saunders is the instance of the common groundnut. That a single nut is a single carpel lodging a couple of seeds is generally accepted; but she contends that the nut is composed of 10 to 12 carpels as revealed by a corresponding number of longitudinally running vascular strands in the wall of the ovary! In spite of overwhelming criticism, however, she is clinging to her theory tenaceously. She has caged herself in the groundnut shell, reinforced by 10 to 12 main bars, a creation of her own imagination. Enveloped in the darkness of that self-erected cage, she shuns light and keeps repeating her untenable theory over and over again as though repetition could compensate for the lack of inherent soundness.

Until nineteen-thirties Goethe's "classical" view was not questioned on fundamental grounds. Evidence based on an accumulation of fossil data and a new interpretation in their light led Prof. Hamshaw H. Thomas to the view that mere metamorphosis does not explain satisfactorily the transition from the vegetative leaf to a fertile organ bearing sexual element. "The Angiospermic flower is *not* the homologue of a vegetative bud". So, he found the progenitor of the modern carpel in a lower Jurassic plant group, the Caytoniales, which, according to Prof. Thomas, show interrelationships between the lower Pteridosperms and the higher Angiosperms. The stamens and carpels exist in Caytoniales as "branch systems"; the modern stamen owes its origin to a form, *Antholithus Arberi*, and the nearest approach to this condition is what we see to-day in the flower of buttercup, poplar and walnut. Fossils like *Caytonia* and *Gristhorpia* are presented by Prof. Thomas to depict the ancestral condition of the modern carpel. These bodies lodging ovules (also called "ovaries" by him) are arranged in pairs on a main axis; during evolution, reduction and fusion have played a great role, a transitional stage in this process being represented in a hypothetical form, in which the pairs of "ovaries" are reduced to a single pair and the main axis becomes stunted; side by side with this process, lateral fusion of the two "ovaries" of the pair was accomplished so much so the ovule-bearing margins lie side by side. A complete fusion of the "ovaries" with one another and that of fused ovaries with the reduced main axis, result in the ultimate expression of the modern carpel. In short, "sterilisation of structures originally fertile is much more likely to have taken place than the metamorphosis of leaf-like structures into reproductive organs".

There are certain serious objections to this view. Apart from those legitimately raised against Prof. Thomas' terminology like "palmate sporophyll", "ovaries", etc., the most important criticisms are, that the evidence is one-sided being largely taken from fossils; that certain observations on the nature of living forms do not lend support to his argument; that the chain is broken at very crucial points; and that convincing intermediate stages are not in evidence at present, so essential for an understanding of the transitions.

An entirely new and striking idea as to the nature of the flower has been put forward by Prof. MacLean Thompson since the nineteen-

twenties. The evidence which has enabled him to put forward this theory has been collected by a study of what he calls "Developmental Morphology". The most significant feature of this view is the total rejection of the very existence of floral entities as carpels and stamens. "His theory directs attention to the flower as potentially sporogeneous axis-bearing floral parts which are not distinct entities but local extensions of the torus". The lower part of the primeval axis is sterile and gives rise to enations like bracts, bractioles and sepals. The upper part is potentially sporogenous. Into this mass sterility penetrates and advances to such an extent as to find the climatic expression in the modern flower, in which fertility becomes confined to the anthers and the surface of the hollow invagination of the receptacle; at whatever point on this fertile surface there is an accumulation of favourable nutrition, ovules emerge out as protuberances. The entire phenomenon of the "state of flowering known as Angiospermy" is thus explained purely on the basis of the principles of growth-physiology. Thus go rejected *in toto* all the current lines of speculation and the very notion of a carpel. According to Prof. Thompson, there is nothing like a carpel in the flower and the flower is "*Acarpous*". The "highlights" in this idea are depicted by the artist in "FUTURISTIC" manner and a human skeleton holds out a mirror in which carpel is seen only as an illusionary reflection.

This theory of "Acarpy" is, at first thought full of vigour, colour and attraction. But the most serious flaw is the gross rejection of the vascular structure indispensable to any morphological interpretation. In a limited sense the vascular structure may not be of much value. However, it does contribute towards an understanding of the "broader trends of race history". Prof. Thompson's views remain unacceptable because of its complete neglect of anatomical data, whose continued role in the verification of our morphological and phylogenetical interpretations are widely recognised.

Although most of the data on hand, developmental and anatomical, are in complete agreement with the "classical" theory, the theory is still imperfect. The Goethean view is regarded by some critics as nothing more than an instrument of description. They find it difficult to explain the derivation of a fertile organ from a sterile vegetative leaf, purely on the phenomenon of metamorphosis.* There is of course, a need for a much more cogent and comprehensive theory, which must be the outcome of a new approach. Saunders, Thomas and Thompson have certainly served us as pioneers in cutting fresh paths of enquiry and have undoubtedly given a new impetus to the study of a problem which was long neglected.

A critical appraisal of the different concepts leads us to the fact that the "classical" view of the flower in general and of its carpel in particular still remains unchallenged, and remains as firm and as solid as the statue of Gomateshwara. This statue at Sravanabelagola in the State of Mysore is a historical monolithic figure of colossal size, standing in the open, withstanding all environmental influences for the last 1,000 years. Even according to Jaina *puranas*, Gomateshwara is a symbol of dignified solemnity. It is said that having renounced the world and its cares, Gomateshwara, the Jain prince, sought peace in the contemplation of the Eternal Truth. He lost all sense of the external world and became so completely absorbed within himself that snakes crawled about his person; anthills enveloped his limbs; and climbing plants twined round his body. These are also chiselled in the great statue. The artist here has made the "classical climber" of Goethe twine round his body.

* Many botanists have, however, expressed the opinion that Goethe used the word "metamorphosis" in a figurative and not in a literal sense.

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LETTERS TO THE EDITOR

OCCURRENCE OF SUMMER DUST OVER DELHI

CONSIDERABLE amounts of dust are transported and deposited over Delhi and the neighbourhood during summer by the wind blowing from western or south-western direction. Wind-borne dust appears in the air from the last week of March and lasts till some portion of July when the monsoon rains start.

Collections of this wind-borne dust have been recognised to be fine soil characteristic of extreme arid zones[1] and in a way they represented the so-called dust soils near desert regions of America.[2] West and south-west of Delhi are the desert regions of the Punjab and the Rajputana. Summer winds of the west may be transporting the fine soil from these regions to deposit them over the more moist regions of Delhi and the neighbourhood.

As a result of these dust showers of summer, the nature of the soil in the neighbourhood of Delhi is bound to be affected. A casual observer will often come across the wind-borne deposits on bare tops of the ridges increasing annually in volume till they start growing vegetation. Needless to say that in composition they bear no relationship either to the adjacent rocky material or to the soil below. Delhi soil does exhibit some characteristics of wind-borne or æolian mixed soils. These are the absence of any striation in the soil and the abundance of kankar nodules at plant root depths.

It is probably now certain[3,4,5,6] that the salt sand and the kankar of the great Thar deserts were brought in by the south-western wind from the sea-shore round about the Ran of Cutch. Spread of alkali salts by wind in U.P. is also known.[7] From the great soil transporting power of the wind, which has been estimated by Prof. Udden[8,9] in America to be several hundred times that of a river, it will be evident that wind is an important agent in soil formation. This is specially true for semi-arid regions, like Delhi where rivers controlled by specific geographical conditions, have long ceased to have any influence on the predominating changes occurring in the soil.

Total deposit during summer over Delhi is of considerable volume. If the figure for a deposit volume during 1942 (*loc. cit.*) is taken, it can be calculated from the number of dusty days as detailed in this article, that a deposit of one inch thick occurs in every seven years. Taking various other considerations of re-transport from drier regions a fair estimate for each inch of thickness of deposit is approximately ten years.

During the summer of 1942, wind-borne deposits were collected during dust storms and analysed for different mechanical fractions. There seemed to be not much difference in the composition between different deposits. Accurate collection of dust could not be continued due to several difficulties. A record of general weather conditions was, however, continued the days during which transported dust was felt in the air were marked as dusty. It is from the number of dusty days during each summer month from March to July that it is found that they could be correlated to a cer-

tain extent with other simple meteorological factors such as temperature, wind velocity, humidity and rainfall. The present is a record of the observations kept for four years, 1940-43.

The following table contains the averages of some meteorological factors and the number of dusty days for the period 1940-43:—

Month	Rainfall in inches	Humidity%	Temp. °F.	Wind Velocity in miles per hour	No. of Dusty Days
January	1·0	78	49	5·9	..
February	0·9	65	55	7·2	..
March	0·1	43	68	8·5	4
April	0·3	30	80	8·7	9
May	0·3	29	89	10·2	19
June	1·7	49	89	9·4	12
July	6·2	73	87	10·2	5
August	8·2	83	83	9·5	..
September	3·1	73	80	7·7	..
October	..	57	74	5·8	..
November	..	47	62	4·5	..
December	0·3	67	51	5·4	..

It appears that it is in the month of May the driest of the year, that the largest number of dust storms occur. This has also been found in Oklahama by Langham and others.[10] Kelogg[11] recorded similar observations.

It can be concluded that the number of dusty days in any summer month varies directly as the wind speed and the temperature and inversely as the humidity and rainfall.

From various considerations this is not altogether unexpected. Thus occurrence of dust in the air is intimately connected with meteorological conditions. Driest and warmest years are expected to have dustiest summers and this is probably true for all localities situated in arid and semi-arid regions.

Imperial Agric. Res. Institute,
New Delhi, ABHISWAR SEN.
August 7, 1945.

1. Sen, *Curr. Sci.*, 1943, **12**, 2, 55. 2. Hilgard, *Bull. Weather Bureau, U.S. Deptt. of Agriculture*, 1892. **3**. 3. Blanford, *Journ. Asiatic Soc. Bengal*, 1876, **55**, 2, 99. 4. Holland, *Rec. Geol. Sur. Ind.*, 1908, **38**, 1, 51. 5. Holland and Christie, *Ibid.*, 1909 **35**, 39. 6. La Touche, *Mem. Geol. Surv. Ind.*, 1911, **35**, 35, **39**. 7. Buck and Wright, quoted in *Agri. Ledger*, 1897, **7**, 5. 8. Udden, quoted in *Rocks, Rock weathering* by G. P. Merril, 1886, 294. Footnote. 9. Udden, quoted in the *Soil Solution* by F. K. Cameron, 1894, 21. 10. Langham *et al.*, *Journ. Amer. Soc. Agron.*, 1938, **30**, 2, 139–45. 11. Kellog, *U.S. Deptt. Agri. Misc. Pub.*, 1935, 221, **1**.

A RELATION BETWEEN THE SHEAR CONSTANT c_{44}, MELTING POINT AND INTERATOMIC DISTANCE OF METALS

IT is usual, in the study of the solid state of matter, to correlate the various physical properties of solids to their lattice constants and obtain the latter independently from them. A similar study reveals that the shear constant c_{44} of all metals crystallising in the cubic system is intimately related to their melting-points and the interatomic distances. It is found that the following relation holds good:

$$\frac{(c_{44})_0 r^3}{T_m} = 9{\cdot}0 \times 10^{-15}$$

$(c_{44})_0$ is the shear constant of single crystals at the absolute zero, r is the interatomic distance and T is the melting-point in degrees Kelvin. The interatomic distance calculated from the above formula on substituting the known values of c_{44} and T_m are given in the table. With the exception of α Fe, c_{44} for all the metals have been taken from our earlier paper[1] where their values at the absolute zero were estimated. The room temperature values have been used for W, Pb and α Fe. On account of the small coefficient of expansion of tungsten, we do not expect a large difference between the room temprature and the absolute zero values of c_{44} in that case, but in the other two cases the difference may be of the order of 10 per cent. The errors of measurement of c_{44} are, however, generally larger. It will be seen that the difference between the calculated and experimental values of r is never more than 5 per cent., which is of the order expected from the uncertainty of about 15 per cent. in the values of $(c_{44})_0$.

It is interesting that a change from the face-centered to the body-centered structures does not effect the validity of the formula.

Structure	Metal	$r \times 10^8$ calculated	$r \times 10^8$ experimental
Face-centered ..	Al	2·96	2·86
	Ag	2·82	2·86
	Au	2·89	2·87
	Cu	2·46	2·55
	Pb	3·35	3·49
Body-centered ..	W	2·78	2·73
	αFe	2·41	2·47
	Li	3·14	3·04
	Na	3·78	3·72
	K	8·87	4·62

BISHESHWAR DAYAL.
Physics Department,
Benares Hindu University,
September 9, 1945.

1. Dayal, *Proc. Ind. Acad. Sc*, 1944, **A**, **20**, 24.

A NEW HYPOTHESIS FOR THE MECHANISM OF ACTIVATION OF SUBSTRATE MOLECULES BY ENZYMES

ACTIVATION of molecules in chemical processes is very generally accepted to be due to collision between reactant molecules with sufficient violence, resulting in transformation of kinetic energy of translation into vibrational energy

within the molecule. Enzymes, however, are peculiar in bringing about reactions at much lower temperatures and hence must be assumed to have acted according to one or other of the two following mechanisms:

(*i*) By making the reaction follow some different path, which entails much less energy consumption; an intermediate complex of enzyme substrate is formed which can then break into the reaction products liberating the enzyme again.

(*ii*) By supplying energy[1] to the system of reacting molecules necessary for their activation; Medwedew[1] has rejected the intermediate complex mechanism and proposed one in which the molecules of the enzyme can activate the substrate molecules according to the following scheme:—

$$(a)\quad F + h\nu \longleftrightarrow F^*$$
$$(b)\quad S + h\nu \longleftrightarrow S^*$$
$$(c)\quad S^* \longrightarrow R^* + P$$
$$(d)\quad R^* \longrightarrow F^* + R$$

F (enzyme molecules) become activated (F^*) by taking a quantum from the energy liberated in decomposition. F^* collides with the substrate S and activates them to S^*. R and P are products of decomposition.

The following facts are, however, clear from both the theories:—

(i) The outstanding property of enzymes, *viz.*, their specificity has not been adequately explained. Theory of active groups and centres when reviewed critically degenerates into something like arguing in a circle (*cf.* Bayliss[2]).

(ii) The enzymes are known not to contain any other group than the ordinary proteins; why not then all the proteins are catalytically active?

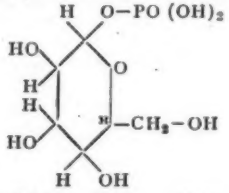
(iii) Even in any given reaction the view that substrate molecules have some definite active groups appears to be opposed by the observations of Munch and Kuhn[3] on sucrose inhibition.

The following mechanism for the activation of substrate molecules by the enzyme, is, therefore, proposed as a preliminary hypothesis. The enzyme molecules are unstable bodies at the ordinary temperature; due to this fact the enzyme molecules can give off energy, the transference of energy from the enzyme to the substrate molecules occurs by virtue of the (i) resonance between some group or atomic vibration in the substrate and some characteristic frequency in the enzyme molecule (primary activation). (This must occur prior to any enzyme-substrate complex formation, if any such compound formation occurs). A similar mechanism of resonance has been postulated to explain the high efficiency of exciting the lower vibrational states of ethylene by hydrogen.[4]

(ii) From this excited group or atom of the substrate molecule distribution of energy among the various other bonds may occur *under the influence of the enzyme*, so that energy may finally be stored in the bond which will be the seat of chemical reaction (secondary activation). Such redistribution of energy to other parts of the molecule from one particular bond which primarily receives energy is known to occur in the photo-chemical decomposition of ketene[5] and also in some prototropic changes.[5]

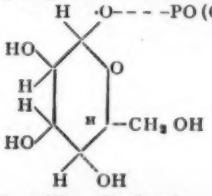
It has, however, been shown that activation by absorption of infra-red radiation is hardly possible; however great the energy density, the fundamental frequencies cannot decompose the molecule because the energy of the quantum is not large enough, and a harmonic having sufficiently high frequency is not absorbed.[6] It appears possible, however, that the energy required for the reaction may be absorbed not in a single quantum of certain frequency but in terms of several quanta at a correspondingly lower frequency.[7] A further possibility may be presented in a stepwise absorption of vibrational energy, the next step of absorption occurring only after excitation has died down by distribution of energy among other bonds.

The case in point may best be illustrated by one arbitrary example, *e.g.*, glucose-1-phosphate → polysaccharide with phosphorylases.



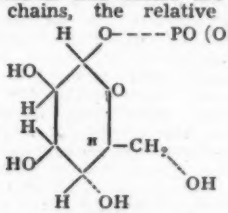
(i) The etheric oxygen atom is set into resonance vibration by the enzyme, (ii) part of the excess energy goes over to the upper part of the molecule and is located in O — P bond while the rest flows down the lower part, one fraction exciting the C_6 — OH bond while the other is located in the C_4 — OH bond. For steric reasons the C_2 — OH bond cannot become chemically reactive by absorption of energy.

Depending on the nature of the phosphorylases, a relative distribution of energy between the C_6 — OH bond and C_4 — OH bond occurs, in the case of plant phosphorylases the former is very little excited, practically the whole share going to the latter, while an *almost* equitable partition of energy between the two bonds occur in the case of animal phosphorylases. The result can be shown thus: (i) For plant phosphorylases: If this now condenses



with itself with elimination of phosphoric acid, starch will result (i.e., glucose 1 : 4 glucoside chains) and for the second case: (ii) for animal phosphorylases: Condensation of this with itself will give rise to branched chain carbohydrates in which some are glucose—1 : 4-

glucoside chains and others are glucose—1 : 6-glucoside chains, the relative excitation of



C_n—OH and C_4—OH bonds determine unit chain length, i.e., whether glycogen or amylopectin will be formed. Hence animal and plant phosphorylases would appear to differ only in degree and not fundamentally in their mode of action. Since monomolecular decomposition occurs by virtue of a "time-lag" between activation and decomposition due to redistribution of energy among the various degrees of freedom, such a system as above will be expected to decompose unimolecularly.

Let us now review some of the enzymic properties in the light of the above hypothesis.

Specificity.—Specificity of enzymes is determined by the fact that approximate coincidence or 'matching' between the characteristic frequency of the enzyme and that of some group, etc., of the substrate molecule must occur. Since it is known that frequency of a group may remain more or less unchanged or unaffected by other parts of the molecule, it is no wonder that compounds with similar structure should be the substrate for the same enzyme.

Inhibition.—(i) Competitive type: this occurs when the primary activation, *viz.*, resonance of the inhibitor molecule with the enzyme molecule can occur but the second step, *viz.*, distribution and localisation of energy in some suitable part of the inhibitor molecule, which may react chemically is not possible. Hence this type of inhibition occurs only with molecules which are chemically related to the substrate.

(ii) Non-competitive type: When the inhibitor molecule may react with the substrate molecule or enzyme molecules so that they become "out of tune", activation is inhibited and the reaction retarded.

Energy of activation.—It is generally found that the heat of activation is smaller for the enzymic decomposition of any chemical compound than the non-catalysed process. It is evident that in thermal activation, all parts of the molecule must be raised to a high level so that a particular bond which is to break may have a definite amount of vibrational energy; but in the enzymic process the enzyme can by its influence cause the energy to be specifically located in the said bond and thus can dispense with the extra amount of energy which goes to other parts of the molecule. It follows from our present scheme that when the primary absorption of energy occurs at a bond which is also the seat of chemical reaction, the heat of activation will be expected to be a minimum; but when this is not the case, i.e., when the second phase of activation, *viz.*, localisation of energy in some other bond is required naturally the heat of activation will be expected to be greater.

Effect of a slight change in substrate or enzyme.—A slight change in substrate may serve to make it in better harmony with the enzyme, *e.g.*, native egg albumin is slowly hydrolysed by trypsin, but slight heating of the solution makes it very susceptible to attack by the enzyme. For the similar case of trypsin on keratin it is known that the appearance of —SH groups is not responsible for the observed phenomenon. Activators of enzymes may also be effective in the same way.

In this connection a closer study of (i) coupled reactions such as xanthine oxidase + xanthine + catalase + ethyl alcohol; (ii) action of mixture of two enzymes on the same substrate, *e.g.*, Haworth's 'Q' factor and Hanes' potato phosphorylase on glucose-1-phosphate; (iii) change of the nature of reaction with the same enzyme under different experimental conditions, *e.g.*, muscle phosphorylase *in vitro* and *in vivo*; (iv) reactions in which one enzyme catalyses the direct side and another (and a quite different one) catalyses the reverse, will be of interest. According to our present conception, specificity being determined by some frequency in the enzyme molecule, may be susceptible to change under different experimental conditions and is not rigid depending upon some unchangeable active groups.

The real test of a hypothesis lies, however, in its quantitative aspect; but since the infrared and Raman data on complex molecules are meagre and since the interaction of the various energy states in the complex molecule is difficult to anticipate, a full mathematical treatment is not easy.

Biochemical Laboratory,
Bose Research Institute,
Calcutta, A. K. Rai Chaudhury.
May 1, 1945.

1. Gortner, R. I., *Outlines of Biochemistry*, 2nd Ed., p. 919. 1*a*. Medwedew, *Enzymologia*, 1937, **2**, 1, 31, 53. 2. Bayliss, W. M., *The Nature of Enzyme Action*, 5th Ed. p. 146–7. 3. Munch and Kuhn, *Z. Physiol. Chem.*, 1925, **150**, 220. 4. Richards, *J. Chem. Phys.*, 1936, **4**, 561. 5. Norrish, Crone and Saltmarsh, *J.C.S.*, 1933, 1533. 5*a*. Watson, Nathan and Laurie, *J. Chem. Phys.*, 1935, **3**, 171. 6. Cross and Daniels, *J. Chem. Phys.*, 1933, **1**, 54. 7. Taylor, H. S., *Treatise on Physical Chemistry*, **2**, 2nd Ed., p. 1564.

CUPRIC-AMMINO-SULPHATES

A. K. Dey and A. K. Bhattacharya[1] have reported evidence from the electrical conductivity measurements of the existence of cupric-amino-sulphates having 2, 4, 5 and 6 molecules of ammonia for a molecule of copper sulphate. In another publication[2] these authors report that they have succeeded in isolating a blue amino-copper sulphate having five molecules of ammonia for one molecule of copper sulphate. The existence of the aforesaid amino-compounds and of others having intermediate composition has been concluded by previous workers from a systematic study of some physical properties of copper sulphate and ammonium hydroxide system. Bhattacharya and

Dey have observed the existence of a new compound containing six molecules of ammonia.

These amino-compounds are formed by the addition of ammonium hydroxide to a solution of copper sulphate. If this addition is done gradually, a precipitate first comes down; with further addition of ammonia it goes into solution developing an intense blue colour. A study of the absorption spectra of this solution by Bhatnagar, Goyle and Prasad has shown that the main blue colour is more or less identical in nature when various concentrations of ammonia are used. This would not happen if definite compounds of different compositions are formed, that is, cupric-ammonium sulphates containing ammonia in definite different proportions do actually exist. Bhatnagar, Goyle and Prasad[3] have shown that the absorption band obtained with the intensely blue-coloured solution formed by the addition of ammonia to copper sulphate is identical with that obtained with a suitably prepared colloidal solution of copper hydroxide. These observations would lead to the conclusion that the variety of the copper ammonia compounds obtained by Bhattacharya and Dey and other workers are adsorption complexes, containing different proportions of ammonia, formed by the peptising action of ammonium hydroxide or ammonium salts on copper hydroxide.

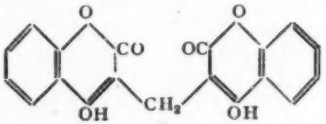
S. S. Bhatnagar.
Mata Prasad.

Laboratories of Scientific &
Industrial Research, Delhi; and
Chemical Laboratories, Royal Institute
of Science, Bombay.
September 13, 1945.

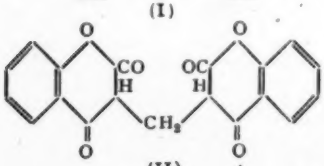
1. *Curr. Sci.*, 1945, **14**, 69. 2. *Ibid.*, 1945, **14**, 201. 3. *Koll. Zeit.*, 1928, **44**, 79.

ON "DICOUMARIN"—SYNTHETIC ANTI-COAGULANT

In search for the causative agent of the hæmorrhagic disease of cattle on feeding spoiled sweet clover hay, it was noticed that 3, 3[1]-methylene-bis-(4-hydroxy) coumarin (I) is the substance that is acting as an anti-coagulant. It has since been synthesized from 4-hydroxy coumarin and is being suggested as an effective agent in post-operative thrombophlebitis, puerperal thrombosis, and pulmonary embolism.



(I)



(II)

It is of interest to note that this naturally occurring coumarin in sweet clover hay is acting as an anti-coagulant whereas other coumarins from *E. Ayapana* are known (*cf.* Dymock *et al.*,[2] and Bose and Ray[3]) to act as coagulants. The above coumarin derivative (I)—also commercially known as "Dicoumarin", possesses no *in vitro* activity whereas the well-known anti-coagulant, heparin, is active both in *in vivo* and *in vitro*. Does it indicate that "Dicoumarin" is not a coumarin but a chromone of the structure (II)? Link and his collaborators[4] have published a series of papers on the chemistry of 4-hydroxy coumarin from which this "Dicoumarin" is being produced synthetically. But the formation of its salts, its reaction with bromine, behaviour towards alcoholic ferric chloride and certain ketonic reagents, condensation with compounds containing active methylene group and many other reactions, indicate the non-existence of a hydroxy group in these 4-hydroxy coumarins. This, in other words, indicates that the compound may also exist in the form (II) when it becomes a 2-keto chromone derivative and as such may differ physiologically from the other natural coumarins as isolated from *E. Ayapana*. Details of the work are going to be published elsewhere.

Bengal Immunity Research Laboratory, Calcutta, *July* 10, 1945.
S. P. Dhar.
U. P. Basu.

1. Cambell and Link, *J. Biol. Chem*, 1941, **138**, 21. 2. Dymock *et al.*, *Pharm. Indica*, **2**, 245. 3. Bose and Ray, *J. Ind. Chem. Soc.*, 1936, **13**, 586. 4. Link *et al.*, *Jour. Amer. Chem. Soc.*, 1943, **65**, 2288 and subsequent papers.

A NOTE ON THE OCCURRENCE OF *ALCALIGENES RADIOBACTER* IN THE AERIAL ROOTS OF *PHOENIX SYLVESTRIS*

Palacios and Bari, in a previous article,[7] had reported the presence of a new organism in the nodules of *Cajanus indicus*. Since then Bergey[2] had also referred to it suggesting that the organism mentioned to by those workers may well be *Alcaligenes radiobacter*, despite the well-marked differences exhibited by the new species. The present workers too had an opportunity of isolating a new micro-organism from the aerial roots of *Phœnix sylvestris*, but in agreement with Bergey's opinion that no new organism should be labelled as new species (to avoid multiplication of the species), but should be, as far as possible, referred to as a variant of one of the existing species, the new organism has been named only as *Alcaligenes radiobacter*.

Phœnix sylvestris is a palm not yet adequately studied. d'Almeida and Correa[1] only recently have studied in detail the anatomy of this plant, and in agreement with the report of Kuster[5] in connection with *Phœnix rectinata*, these workers have also observed the presence of *yellowish brown contents* occurring in the cortical cells of *P. sylvestris*. Richter[8] con-

sidered these contents in *P. rectinata* as those of tannin, but the present authors observed (on microscopical examination) that the contents of *P. sylvestris* were motile. With a view to ascertain if these yellowish brown contents were living organisms, some of the aerial roots collected from different plants of *P. sylvestris* were inoculated on meat-infusion agar, Czapek agar, Congo-red media of Kellerman[4] and of Leonard[6] after that they had been treated by a mercuric chloride solution as recommended by Harrison and Barlow.[3] The plates on incubation revealed the growth of some colonies: yellow colonies were observed on meat-infusion agar; on Kellerman's medium the colonies (whitish) were practically not absorbing the dye; on Leonard's they were clearly coloured but were not typically looking like those of *A. radiobacter*; the Czapek agar gave rise to slimy white colonies like those of *Klebsiella pneumoniæ*.

The apparently different organisms isolated on these media were eventually proved to be one and the same species; the pigment appearing on meat-infusion agar was lost on Czapek for mucilage and *vice versa*. The micro-organism on routine cultural examination consistently revealed the following characteristics:—

Morphology: Rods, 0·54 to 0·75 by 1·13 to 1·41 microns, actively motile, peritrichically flagellated, non-capsulated, non-spore bearing and found in groups. Gram negative. *Infusion agar slant*: Abundant, slightly slimy, translucently greenish-yellow. *Agar colonies*: Minute, moist, raised, circular, greenish-yellow. *Czapek agar*: Abundant, slimy, white; no sign of yellow pigment. *Infusion broth*: Heavy, general turbidity, thin pellicle, mucoid deposit. *Peptone water*: Moderate, otherwise same as in the broth. *Potato*: Abundant, lemon-yellow to light red pigment. *Gelatine colonies*: Slimy, not well-pigmented; gelatine not liquefied. *Nitrates*: Reduced to nitrites. *Indol*: Not formed. *Hydrogen sulphide*: Not produced. *Sugar media*: No observable reaction; abundant growth in presence of mannite, glucose, lactose, dextrine and maltose, but not saccharose. *Starch*: Feebly hydrolysed. *Milk*: Strongly alkaline. *Pigment*: Slightly soluble in water, soluble in 95 per cent. alcohol, insoluble in chloroform, ether and carbon disulphide. *Carbohydrates agar*: Whitish colonies, very slimy instead of pigmented. Presumably mucilage prevents chromogenesis by cutting off the oxygen supply. *Carbohydrate-free agar*: Solidified peptone water proved to be a poor medium; meat-infusion agar (with sugars eliminated by *E. coli growth*) was the best for chromogenesis. *Adaptation Power*: Eight months' adaptation on infusion agar made it lose to a great extent its slime production on Czapek; the property was regained in serum-milk. *Optimum temperature*: 28° C. *Nitrogen fixation*: Slight power.

All the observations lead to the conclusion that this is a new species; but because of its occurrence in the endophytic state and of its resemblance to *A. radiobacter* (despite very many well marked differences) the authors are inclined to label this new species as a variant of *Alcaligenes radiobacter*.

SUMMARY

Presumably a new micro-organism, but labelled for convenience as a variant of *Alcaligenes radiobacter*, isolated from the aerial roots of *Phœnix sylvestris* is described at length.

Microbiology Dept.,
St. Xavier's College,
Bombay,
July 1945.

J. V. BHAT.
F. FERNANDES.

1. d'Almeida, J. F. R., and Correa, J. C., Private communication "Studies in the root-habits and anatomy of Indian Plants," *M.Sc. Thesis*, 1945 2. Bergey, D. H., "Manual of Determinative Bacteriology," 5th Ed., 1939, Bailliere, Tindall & Cox, London. 3. Harrison, F. C., and Barlow, B., "The nodule organism of the Leguminosæ—its isolation, identification and commercial application," *Centralbt. Bakt. (etc.)*, II Abt., 1907, **19**, 264–72, 426–41. 4. Kellerman, K. P., "The reaction of crown gall to legume inoculation," *U.S. Dept. Agr. Bur. Plant Indus. Circ.*, 1911, **76**, 6. 5. Kuster, E., "Pathologische Pflanzenanatomie" Jena, 1916. 6. Leonard, L. T., "*Bacillus radiobacter* in reference to commercial legume inoculants," *Jour. Bact.*, 1931, **21**, 543–56. 7. Palacios, G., and Bari, A., "A new micro-organism associated with the nodule-bacteria in *Cajanus indicus*," *Proc. Ind. Acad. Sci.*, 1936, **3**, No. 4, Sec. B, 362–65. 8. Richter, E., "Physiol-Anat unt ü Luftwurzeln Bibliotheca," *Bot.*, 1901, **10**, Heft. 54.

A PRELIMINARY NOTE ON THE ANTIBACTERIAL SUBSTANCE FROM *ASPERGILLUS FLAVUS*

WHITE (1940) first observed that *Aspergillus flavus* when grown on certain liquid medium yielded a filtrate that showed anti-bacterial activity against gram-positive and gram-negative bacteria. Glister (1941) obtained anti-bacterial concentrate from *Aspergillus flavus* but did not isolate it in a crystalline form. Bush and Goth cultivated *Aspergillus flavus* on the surface of the liquid medium and obtained an anti-bacterial substance. This substance which is soluble in ether and water was called Flavicin. It was extracted by the authors with isopropyl ether in an atmosphere of carbon dioxide. The crude product, toxic to mice, was found to be innocuous after purification. Waksman and Bougie (1943) used six strains of *Aspergillus flavus* and five of *Aspergillus flavus orizæ*, the latter yielding little or no anti-biotic substance. According to them two factors were responsible for the anti-biotic activity, namely, aspergillic acid, which is active both against gram-positive and gram-negative bacteria and flavicin mostly active against gram-positive bacteria and, therefore, very similar to penicillin. The strain of *Aspergillus flavus* under submerged condition of growth, produced enough flavicin to be compared favourably with penicillin produced by the best strain of *Penicilium notatum* grown under similar conditions. McKee and MacPhillany (1943) found from *A. flavus* antibacterial substance unlike aspergillic acid and closely resembling penicillin in its biological and chemical nature. Menzel *et al.* (1943) gave

detailed comments on anti-biotic substance elaborated by a strain of *Aspergillus flavus* and an unclassified mould. The authors fully explained the chemical nature of pure aspergillic acid in crystalline form which was tested against and staphylococci and other organisms in high dilutions. Jones *et al.* (1943) also found similar substance using the same strain of the fungus, but one of the variants showing Chlamydospores gave more potent antibacterial substance than others.

MATERIALS AND METHODS

A strain of *Aspergillus flavus* which was found to contaminate a flask of tomato juice and giving a zone of inhibition (25 mm.) against *Staphylococcus aureus* by cup-and-plate method was selected for the work. This fungus when grown on Difco Peptone-agar at pH 7·6 gave an inhibition zone of about 15 mm. (when the growth is 2 mm. in two days). The fungus when grown on Sauboraud's medium (glucose-agar) showed yellow spores at first, which gradually became green, changed to deep green and later dirty brown in colour. The strain was maintained in Sauboraud's medium, but before inoculation it was cultivated in test-tubes containing bran sterilized by autoclaving. Yellow green spores developed in these tubes in three days when they were easily dispersible, and inoculated on the surface of the liquid medium. Cultivation of spores direct from Sauboraud's medium gave similar results.

Strains of *A. flavus* isolated from different sources, namely, bread, wheat, flour, fruits, etc., were found to give antibacterial substances in approximately same quantities when grown under similar conditions. All the cultures were maintained at the room temperature varying from 25° C. to 35° C. at Calcutta and no degenerative changes were noticed. A strain of *A. flavus orizæ* which was used for the routine production of Taka-diastase was tried for its antibacterial activity with respect to the development of antibacterial substance in different media described elsewhere. This did not produce any antibacterial substance whatsoever. Some of the strains when used to produce diastase were found to be as rich in diastase as any of the preserved strains of *Aspergillus flavus oryzæ*.

Various laboratory media were tried to find one that would give a maximum titre of antibiotic substance against *Staphylococcus aureus*. As a rule liquid media were used, but semi-solid medium containing ·5 per cent. agar gave

TABLE I

Serial No.	Medium	pH	Growth and sporulation	Maximum dilution of the filtrate in which antibacterial activity (a.a.) is marked against *Staphylo aureus*.
1	Doglas broth	7·6	Thin mat. Few spores 7th day.	1/40 dil.
2	Semi-solid agar	7·6	Thick white mat. Spores Nil.	1/80 dil.
3	Bacto-peptone 2%	6·7	Soft moist mat. Spores Nil.	1/10 dil.
3a	Bacto-peptone 2%	7·4	Soft moist mat. Spores Nil.	1/40 dil.
4	Bacto-peptone 2% & 2% cane sugar..	6·7	Thin mat with green & then brown spores. Spores 3rd day.	No a.a. in 1/10 dil.
4a	Bacto-peptone 2% & 2% cane sugar ..	7·4	Thin mat with green & then brown spores. Spores 3rd day.	1/10 dil.
5	Bacto-peptone 2% & sod. acetate 1%	6·7	Thin moist mat. Spores Nil.	No a.a. in 1/10 dil.
5a	Bacto-peptone 2% & sod. acetate 1%	7·4	Thin moist mat. Spores Nil.	No a.a. in 1/10 dil.
6	Bacto-peptone 2% & 2% cane sugar & sod. acetate 1%	6·7	Thin moist mat. Spores 3rd day.	No a.a. in 1/10 dil.
6a	Bacto-peptone 2% & 2% cane sugar & sod. acetate 1%	7·4	Thin moist mat. Spores 3rd day.	1/10 dil.
7	Casein peptone 2%	6·7	Moist mat. Spores Nil.	1/10 dil.
7a	Casein peptone 2%	7·4	Moist mat. Spores Nil.	1/40 dil.
8	Casein peptone 2% & cane sugar 2%	6·7	Thick mat with moist areas on surface. Spores Nil.	1/10 dil.
8a	Casein peptone 2% & cane sugar 2%	7·4	Thick mat with moist areas on surface. Spores Nil.	1/50 dil.
9	Casein peptone 2% & sodium acetate 1%	6·7	Thick mat. Spores Nil.	1/50 dil.
9a	Casein peptone 2% & sodium acetate 1%	7·4	Thick mat. Spores Nil.	1/10 dil.
10	Casein peptone 2% & cane sugar 2% & sod. acetate 1%	6·7	Thick crumpled mat with dew drops like moist areas on the surface. Spores Nil.	1/10 dil.
10a	Casein peptone 2% & cane sugar 2% & sod. acetate 1%	7·4	Thick crumpled mat with dew drops like moist areas on the surface. Spores Nil.	1/30 dil.

very satisfactory results. Various modifications and combinations of Czapeck-dox synthetic media with and without cane-sugar and also in combination with steep water, yeast extract and peptone were tried without any encouraging result. At this stage it was found that nutrient agar which was prepared from trypsin-digested meat gave a good growth of the fungus at pH 7·6 without spore formation and showed inhibition against *Staphylococcus aureus*. So trypsin-digested broth was selected for further study of the fungus. The initial pH of the medium at which antibacterial activity was marked was between 7·4 to 7·6. Trials were conducted with casein-peptone (trypsin-digested), bacto-peptone with and without sucrose at pH 6·7 and 7·4. Sodium acetate was supplemented in similar series. The results of all these experiments are shown in Table I. From third day after the inoculation the antibacterial activity was observed and the maximum development of antibacterial substance was noticed between ninth and thirteenth day depending on the growth of the fungus mat.

The following characteristics may be pointed out regarding the development of the antibacterial substance :—

(1) Development of the antibacterial substance depends on the particular strain of the fungus.
(2) Formation of good mat is essential but without sporulation.
(3) Sporulation is harmful for the development of antibacterial substance.
(4) pH 7·4 gives a better result for development of antibacterial substance than a pH 6·7 or 6.
(5) In all cases antibacterial substance was found to develop between nine and thirteen days after inoculation of fungus depending on the quality of mat-formation.
(6) The final pH of the medium was found to be between 8·4 and 9 when the maximum antibacterial activity developed.

CONCENTRATION

An attempt was made to concentrate the filtrate containing the antibacterial substance and the following process was adopted.

The fungus-free filtrate which was slightly alkaline in reaction was treated with acetic acid till the pH was 3·5. This was then adsorbed by activated charcoal (about 2 per cent. W/V). (A second adsorption is necessary if the filtrate is not clear.) Charcoal was filtered after 3 hours when clear filtrate was recovered. The charcoal was dried on the filter-paper. The dry charcoal was then eluted with ether or chloroform and refluxed for 4-6 hours.

The elution was found to be incomplete with ether and, therefore, in later experiments it was eluted with chloroform. After the elution charcoal was filtered off and the clear dark orange coloured chloroform extract was evaporated to dryness.

The residue was treated with 2 per cent. sodium bicarbonate and tested for antibacterial substance. It was found that the total antibacterial unitage in the whole fluid could be approximately recovered. Further work on the isolation of the active principle is under progress.

The advantages of antibiotic substance from *Aspergillus flavus* in the tropics over penicillin obtained from *P. notatum* are manifold, important of which are :—

(1) The fungus is easily isolated from everyday contamination in the tropics.

(2) It requires no special method for the preservation of spores but in the case of *Penicillium notatum* a special method has to be followed to maintain spores to have maximum yield of penicillin.

(3) The cultures may be cultivated at the room temperature of the tropics varying from 25°-35° C. in a place like Calcutta and no special arrangement is necessary in an air-conditioned chamber for the regulation of temperature during incubation for the optimum yield of penicillin.

The Research Laboratory,
Bengal Immunity & Co., Ltd.,
Calcutta, N. C. DEY.
June 21, 1945.

1. White, *Science*, 1940, **92**, 127. 2. Waksman and Bougie, *Chem. Abstr.*, 1943, 6301. 3. White and Hill *J. Bact.*, 1943, **45**, 433. 4. Glister, *Nature*, 1941, **148**, 470. 5. Jones, Helan, *et. al.*, *J. Bact.*, 1943, **45**, 461. 6. McKee and MacPhillany, *Ibid.*, 1943, July 1943.

STUDIES IN THE SULPHUR FORMATION AT KONA, MASULIPATAM—PART II

THE isolation and general characteristics of *Vibro desulphuricans*, Konæ has previously[1] been demonstrated to be responsible for sulphate reduction in the sulphur areas at Kona. It was of interest to elucidate in greater detail the physical and physiological requirements of the organism for its growth and functioning.

1. *Temperature.*—The organism was inoculated in the stock medium and incubated under anaerobic conditions at various temperatures for 72 hours. The results are shown in Table I.

TABLE I

Temperature of incubation °C.	25	30	37	45
Blackening after ....days	5	3	No Blackening	No Blackening

2. *Thermostability.*—The culture, inoculated in the stock medium was subjected to different temperatures for measured periods; It was then immediately cooled under running tap water (temp. 25° C.) and thereafter incubated at 30° C. for 72 hours, and examined after this period. Table II gives the results.

TABLE II

Temperature °C.	55	60	60	70	75	80	80
Time of treatment in minutes	10	5	10	1	5	0·5	1
Reduction after 72 hours	+	+	nil	+	nil	+	nil

3. *Hydrogen-ion concentration.*—The organism is highly sensitive to changes of pH below 7·0. The capacity to grow and the function to reduce sulphates, were found to be abolished when the pH of the medium was slightly below 7·0 while the maximum pH tolerated was 8·5; the optimum pH was found to lie between 7·2 to 7·4.

4. *Oxygen requirements.*—The organism is a strict anaerobe and under aerobic conditions it has little effect on the sulphates. The culture tubes after inoculation are best maintained in a desiccator containing freshly prepared alkaline pyrogallol and evacuated by a filter pump.

5. *Salinity.*—The organism was inoculated in a basal medium (composition: sodium lactate 0·2 per cent., sodium sulphate 2·0 per cent., dipotassium hydrogen phosphate 0·2 per cent., ferrous ammonium sulphate 0·1 per cent. and ammonium sulphate 0·2 per cent.), containing increasing concentrations of sodium chloride. The cultures were incubated at 30° C. Results are shown in Table III.

It will be observed that optimum salinity for the organism is 6 per cent. and while the reduction can be effected in the absence of sodium chloride, the presence of as high a concentration as 13 per cent. does not affect the activity of the organisms.

6. *Sources of Nitrogen.*—A basal medium (composition: sodium chloride 6 per cent., sodium sulphate 4 per cent., sodium lactate 0·2 per cent., dipotassium hydrogen phosphate 0·2 per cent. and ferric chloride 0·1 per cent.) containing equivalent quantities of different forms of nitrogen (22 mgm. of nitrogen per 100 ml. medium) was inoculated with the culture and incubated at 30° C. The results are shown in Table IV.

It will be observed that organic sources of nitrogen as urea, casein hydrolysate and peptone are more rapidly metabolised than the inorganic forms. Nitrates and nitrites appear to be toxic to the organism.

7. *Sources of carbon.*—A basal medium (composition: ammonium sulphate 0·1 per cent., manganese sulphate 0·2 per cent., calcium sulphate 1·5 per cent., magnesium sulphate 0·2 per cent., sodium chloride 4·0 per cent., potassium dihydrogen phosphate 0·1 per cent. dipotassium hydrogen phosphate 0·2 per cent., and ferrous ammonium sulphate 0·1 per cent.) was inoculated with the culture with different salts of organic acids as sources of carbon. The results are shown below.

TABLE V

Source of carbon	Sodium formate	Sodium succinate	Sodium oxalate	Sodium lactate	Sodium acetate	Sodium citrate
Blackening in days	nil	nil	nil	3	nil	nil

Thus it was found that so far no other salt except sodium lactate was found to be utilised by the organism.

8. *Concentration of sulphates.*—A basal medium (composition: sodium chloride 6 per cent., dipotassium hydrogen phosphate 0·2 per cent., sodium lactate 0·2 per cent., ammonium chloride 0·2 per cent., ferric chloride 0·1 per cent., containing increasing concentrations of sodium sulphate was inoculated with the organisms, and inoculated as usual. The results are shown in Table VI.

TABLE VI

Concentration of sulphates	0·0	0·1	0·2	0·5	1·0	2·0	4·0	6·0	8·0
Blackening in days	nil	nil	2	2	3	3	4	6	nil

The concentrations of sulphate effective in blackening ranges between 0·2 and 2·0 per cent.

9. *Role of fixatives.*—It was found that sulphuretted hydrogen formed during the reaction, if allowed to accumulate, proved toxic to the micro-organism. It was observed that the culture maintained its activity over a longer period (upto two months) if adequate amounts of iron salts were incorporated in the medium.

Thus it is concluded that the organism has

TABLE III

Concentration of sodium chloride in the medium per cent.	0	0·5	1·0	2·0	3·0	4·0	5·0	6·0	7·0	8·0	9·0	13·0
Blackening in.....days	7	6	5	4	4	4	3	2	4	5	6	6

TABLE IV

Form of Nitrogen	No nitrogen	$(NH_4)_2SO_4$	$NaNO_2$	$NaNO_3$	Urea	Casein hydrolysate	Peptone
Blackening.....in days	No blackening	4	nil	nil	2	3	3

an optimum temperature of 30° C. and a thermal death-point at about 60° C. It requires a hydrogen-ion concentration of 7·2-7·4 and is a strict anaerobe. The optimum salinity at which the organism is most active is 6 per cent.; organic sources of nitrogen are preferred; of the sources of carbon studied, only sodium lactate was effective. The organism reduces sulphates in concentrations upto 6 per cent. The viability of the culture is enhanced by fixing the sulphuretted hydrogen released during the reaction with the aid of iron salts.

Our grateful thanks are due to the Madras Government for the generous support of a scheme of which these studies form a part. Thanks are also due to Sir J. C. Ghosh for his kind interest in the course of the work.

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CHEMICAL EQUILIBRIUM IN STYRENE FORMATION FROM ETHYL-BENZENE AT LOW PRESSURES

The chemical equilibrium in the dehydrogenation of ethyl-benzene to styrene has been successfully studied in a specially devised apparatus at the low pressures of 10 to 40 mm. of mercury and in the temperature range of 360-500° C. A catalyst, composed of the oxides of chromium and aluminium promoted by metallic copper, was used. This catalyst, prepared by a special method has been found to possess remarkable activity. Even at atmospheric pressure and upto the temperature limit of 580° C. it gave practically equilibrium yields of styrene from ethyl-benzene.

Using the equation $K_p=\frac{p\alpha^2}{1-\alpha^2}$ where α is the degree of dissociation of ethyl-benzene and p the total pressure in atmosphere, the equilibrium constant of the reaction has been calculated.

$$C_6H_5CH_2\cdot CH_3\ (g) \rightleftharpoons C_6H_5CH=CH_2\ (g)+H_2$$

From the value of K_p, the free energy of the reaction has been evaluated, using the relation:

$$\Delta F_T=-RT\ln K_p.$$

The following table gives the values of k_p and ΔE_T for five different temperatures:—

No.	Temp. °C.	Temp. °K.	K_p	ΔF_T (cals.)
1	360	633	0·00047	9636
2	395	668	0·00160	8545
3	430	703	0·00495	7414
4	460	733	0·01200	6442
5	495	768	0·03100	5299

Using graphical method, the mean value of the heat of reaction (temperature range 360-500° C.) has been found:

$$\Delta H_T=29{,}840 \text{ cals.}$$

The free energy as a linear function of temperature is expressed by the equation:

$$\Delta F_T=27{,}379-32\cdot65\ T.$$

Th temperature of neutral equilibrium is:

$$T_0=565°C.$$

Employing the specific heat equation,

$$\Delta c_p=8\cdot52-0\cdot01405\ T+0\cdot000{,}00566\ T^2$$

evaluated from the values of the specific heats for ethyl-benzene and styrene given by Daniel R. Stull,[1] the following standard free energy equation for the reaction has been obtained:

$$\Delta F_T=27{,}097-8\cdot52\ T\ lnT+0\cdot007025\ T^2-0\cdot000{,}00094\ T^3+23\cdot38T$$

The values of the heat of reaction, free energy and entropy change at standard state are:

$$\Delta H_{298}=29{,}062 \text{ cals.};\ \Delta F_{298}=20{,}229 \text{ cals.};\ \Delta S_{298}=29\cdot64 \text{ E.U.}$$

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ROLE OF WATER-SOLUBLE PHOSPHORIC ACID AS AN ASPECT OF SEWAGE IRRIGATION

Sewage is a fairly rich source of phosphoric acid and nearly one-third of it is in water-soluble form. During sewage irrigation the crop gets readily available phosphoric acid throughout its growth period. This may play a significant role in crop-nutrition as was shown by the senior author[2] in the case of Ragi (*Eleusine coracana*). The phosphoric acid of sewage was shown to be as much responsible for the higher crop yields of Ragi as the nitrogen of sewage and it was also observed that the phosphorous content of Ragi definitely increased due to sewage irrigation. Similar experiments with wheat are now reported.

Using the local black cotton soil, pot experiments with wheat were laid out to study the effect of irrigating the crop with (1) water containing 2 p.p.m. of water-soluble P_2O_5 from superphosphate, (2) water containing 2·5 p.p.m. of soluble nitrogen as ammonium sulphate, and (3) water containing a combination of the above. The last is supposed to represent sewage irrigation. (4) A control of ordinary irrigation was also run. Each treatment was replicated four times. The amount of P_2O_5 and N corresponding to 250 lbs. and 300 lbs. respectively per acre were given in 30 irrigations of 4 gallons each per pot. The yields

of grain and straw along with their N and P_2O_5 contents are given below:—

Control		N. irrigation	P. irrigation	N. P. Irrigation	Standard error	Critical difference P = 0·01
Yield in gm. per pot						
Grain	11·2	19·5	17·7	19·7	1·81	2·75
Straw	8·5	15·7	14·0	19·2	2·72	5·08
N Per cent.						
Grain	2·24	3·27	2·95	3·36	0·18	0·27
Straw	0·33	1·17	0·63	1·36	0·21	0·31
P_2O_5 *Per cent.*						
Grain	0·76	0·71	1·10	1·12	0·11	0·17
Straw	0·07	0·07	0·33	0·61	0·11	0·17

There are significant increases in yields of grains as well as straw either with P- or with N-irrigation. This shows that the soil under experiment responds to application of both N and P. The response to P application may be due to the low available phosphate status of the soil which was found to be 20-25 p.p.m. as per Truog's method. As may be expected, due to N-irrigation, there is significant increase in the nitrogen contents of both grains and straw but not in their phosphorus contents. But due to P-irrigation the phosphorus as well as the nitrogen contents of grain and straw show a significant increase. This is contrary to the observation of the senior author[3] and also of Mukherji and Agarwal,[5] Joret and Malterre[4] and Anne.[1] They found that application of the phosphoric fertilisers in bulk at the beginning of cropping to a P-deficient soil, decreased the nitrogen content of both grain and straw. Thus the effect of application of water-soluble phosphoric acid in irrigation water is distinctly different from that of its application in bulk at the beginning of cropping. As a result of P-irrigation not only more phosphorus but also more nitrogen was made available which resulted in higher crop yields and higher nitrogen and phosphorus contents of both grain and straw. This aspect is being further studied.

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OCCURRENCE OF GOSSYPOL

THOUGH gossypol was first discovered in the cotton seed, it was considered by Carruth[1], to be present in all parts of the cotton plant excepting the woody tissues. This conclusion was based only on the fact that the glands of all these parts gave with concentrated sulphuric acid a characteristic blood-red colour and with alkali a blue colour on exposure to air. But, these colour reactions obtained by Carruth with the several parts of the cotton plant appear to be due to the presence of small amounts of anthocyanins, since even acetic acid gives a permanent red colour. Carruth[1] also reported the extraction of a crude material containing gossypol from the ether extract of the stem-bark but it was not confirmed. Later, Harrison and Hahn[2] showed that the root-bark of the upland short cotton is a rich source of gossypol containing upto a maximum of 0·88 per cent. They also showed that stalk, bark-free root, leaves, squares, and immature bolls contained little or no gossypol. These facts are now confirmed by examining samples of a number of species of cotton plant available in South India.

The method of extracting gossypol employed here is that of Murty, Murty and Seshadri[3] which involves the cold percolation of the dry root-bark with chloroform and precipitating the compound in the form of its dianil with aniline. The recovery of gossypol from the dianil has been effected by means of acetic anhydride. This method of extraction gives the best yields in all the cases examined. The following table gives the data relating to the different sources.

Material	Method of extraction	% Yield of gossypol
1. Seed of *Gossypium hirsutum* (Cambodia)	Method of Murty, Murty and Seshadri	0·7
2. Root-bark of upland cotton according to Harrison and Hahn	Ether extraction	0·88
3. Root-bark of *G. arboreum*	Murty, Murty and Seshadri	1·29
4. Root-bark of *G. hirsutum*	,,	2·6
5. Root-bark of *G. indicum*	,,	3
6. Stem-bark of *G. hirsutum* and *G. indicum*	,,	Nil

As can be noticed the yields of gossypol from the root-bark are much higher than those reported by Harrison and Hahn. This may partly be due to the improved method of extraction adopted in the present examination. Besides being an excellent source it should be noted that the root-bark is free from oil unlike the seed and this makes the extraction very convenient and simple.

The sample of gossypol obtained from the root-bark has been carefully compared with

that obtained from the seeds by the preparation of derivatives and shown to be identical.

The stem-bark which has been carefully freed from any root-bark, on the other hand, yields no significant amount of gossypol. No crystalline matter could be obtained under the conditions employed for the preparation of anil.

Gossypol seems to be specially peculiar to the cotton plant (gossypium group) since the seeds and root-barks of other related plants resembling cotton do not contain gossypol.

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ON THE VIABILITY OF PADDY SEEDS *ORYZA SATIVA*

Studies on the longevity of seeds have engaged the attention of the various research workers. Takagi[7] in mulberry seeds, Kincaid[4] in tobacco seeds, Griffiths[3] in lettuce seeds, Akamine[1] in number of garden and crop plant seeds including rice stored for six years, Kondo[5] in hulled rice stored for four years and Christidis[2] in cotton seeds, have found that by reducing the moisture of the seeds and storing the same under air-tight conditions, viability of the materials is maintained for a longer period. Rodrigo[6] stored air-dried farm crop seeds including rice in air-tight containers. The study was extended for 95·8 months during which period seeds from all the paddy varieties that were stored lost their complete viability in 84·5 months.

Paddy seeds stored under ordinary conditions at Sabour were found to lose complete viability in about nine months. To ascertain the period for which paddy seeds could be made to remain viable, seeds from one pure strain, 36 B.K., were stored after one month from the date of harvest, in various kinds of containers mentioned below. After a lapse of 27 months from the date of storage, samples from the various containers were taken up to determine the viability of the seeds and the results obtained are given below.

The percentage of germination was nil when the method of storage was (1) air-tight tin containers, (2) earthen pots with mouth closed with mud, (3) earthen pots with mud plastered all round, (4) earthen pots with coal-tar plastered all round, (5) glass-stoppered bottles, (6) glass-stoppered bottles with tin-mercury amalgam, (7) desiccator without any desiccating agent (not vacuum), (8) desiccator without any desiccating agent (in vacuum); a hundred per cent. germination was, however, obtained when the method of storage was (9) desicator with calcium chloride, (10) desiccator with calcium chloride (in vccuum), and (11) desiccator with sulphuric acid.

Moisture percentage of the seeds from containers[9,10,11] was found to be 3.6 per cent. as against the 10-12 per cent. of moisture characterising the other seeds. The reduction in moisture content may be responsible for maintaining the full viability of the seeds.

Seed moisture from one pure strain, 36 B.K., of paddy was, therefore, reduced by drying them in the hot sun in the month of May to 4·5 per cent. and 3·6 per cent. and such dried samples were stored in sealed tin containers without any dehydrating agent in several sets. After the expiry of each year, of storage, samples from these containers were taken out to determine their germination percentage. After seven years of storage samples are still continue to show about 80 per cent. of germination. The maximum period, for which they maintain their viability, is still under observation.

A research worker who is testing a large number of varieties and strains under limited means, may thus store a part of his materials with complete safety for some years against loss of viability for examination later on. Moreover seeds of selected varieties and strains, which have been given out for propaganda and demonstration, may be preserved and the labour of maintaining them every year may thus be easily saved.

Grateful acknowledgment is due to late Mr. M. Alam, Rice Specialist, and to Dr. R. H. Richharia, Economic Botanist, Bihar, for giving facility for this work.

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SEED TRANSMISSION OF MELON MOSAIC VIRUS

In connection with the analytical work on viruses nursery of cucurbitaceous plants, *e.g.*, cucumber (*Cucumis sativus* L.), 'tori' (*Luffa ægyptiaca* Mill.), red gourd (*Cucurbita maxima* Duschesne), bottle gourd (*Lagenaria vulgaris* Ser.), bitter gourd (*Momordica cha-*

rantia L.), melon (*Citrullus vulgaris* Schrod) and 'sarda' of Kabul (*Cucumis melo* L.) was raised in sterilized soil in the insect-proof glass house. In the first instance only twelve plants of each type were raised. All the plants thus raised appeared to be perfectly healthy excepting one plant of *Cucumis melo* which showed symptoms of virus infection. At the time the nursery was raised, there was no infected plant in the insect-proof cabin but as a precaution the plants were regularly sprayed with soap and nicotine sulphate twice a week. The occurrence of this case of infection was noteworthy as the disease was suspected to be transmitted through seed. The seeds of *Cucumis melo* were sown during January-February 1945. The germination was much delayed due to prevailing low temperature and the growth of the plants was slow. The first symptoms of infection were observed within a week after the appearance of the first true leaf. The infected leaf first became pale in colour and then gradually developed circular interveinal mottle accompanied by puckering of the leaf-surface. Within the next few days puckering developed to such an extent that the whole leaf appeared to be distorted and the leaf-apex was raised upwards. By this time the plant had put out two more leaves which also showed slight puckering and interveinal mottle (Fig. 1).

FIG. 1

Seed of *Cucumis melo* as well as that of other cucurbits except *Lagenaria vulgaris* Ser. had been purchased from the local market in one lot. The nursery of all the cucurbits was raised in several lots at different times but no case of seed transmission except in *Cucumis melo* was observed. Large number of plants of *Cucumis melo* were raised by planting fifty seeds at a time from the same lot but only 56 per cent. of the plants indicated seed transmission of the virus.

The disease was succesfully transmitted by mechanical means to some cucurbitaceous plants, *e.g.*, *Cucumis sativus*, *Momordica charantia* and to some solanaceous plants, *e.g.*, *Datura stramonium* L. and *Nicotiana tabacum* L. Var. *German samson*. The period required to bring about infection in different hosts varied from 4-7 days. The disease could also be transmitted to cowpea (*Vigna sinensis* Endl.).

The reactions on differential hosts indicate that the causal virus is a strain of *Cucumis Virus*[1] (Doolittle) and that the virus is seed transmitted. The results are similar to those of Kendrick (1934) who described a mosaic disease of musk melons (*Cucumis melo* L.) and proved the disease to be seed transmitted. McClintock (1916) indicated that cucumber mosaic virus might be seed-borne and Doolittle and Gilbert (1919) reported seed transmission of the cucumber mosaic virus by the wild cucumber. The symptoms of squash-mosaic-virus were described by Middleton (1944) who demonstrated the disease to be seed transmitted. Mahoney (1935) also observed seed transmission of a cucurbit virus and reported maximum seed transmission of 33·3 per cent.

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MUSTARD-APHID (*RHOPALOSIPHUM PSEUDOBRASSICAE* DAVIS)

Rhopalosiphum pseudobrassicæ Davis is one of the most serious pests of mustard. In the beginning of the attack the inflorescence of the mustard plant becomes thickly covered with the aphids, as a result of which most of the flowers are destroyed and those that are saved from the attack produce under-developed pods which in their turn become dried up and produce more or less nothing. Later on, the whole plant becomes covered with the

aphids of all stages, their moults, their excreta and the honey-dew; the whole plant is thus destroyed and the crop fails completely. Besides attacking mustard it also attacks many other cruciferous plants, *e.g.*, radish, cabbage, etc. It has also been recorded that the aphid transmits a number of virus diseases, *viz.*, *Brassica virus* 3—causing mosaic of Brassicæ, *Matthiola virus* 1—causing mosaic in stocks, *Phaseolus virus* 1—causing common mosaic in leaves, *Allium virus* 1—causing yellow dwarf in onions. The aphid appears to be of a very great economic importance.

In the beginning of December the *Sexuales*, *i.e.*, the winged males and females appear which copulate and the latter lay eggs on their host plant, *i.e.*, mustard or other cruciferous plants. This is the only time during their whole life-cycle when males appear and the females are oviparous. From the eggs emerge nymphs which are all females and no males at all. The females so produced are apterous, viviparous and parthenogenetic, and are known as *Fundatrices*. The apterous females are not so well developed as the winged females. The sense organs, antennæ and legs are much reduced, and this reduction of the parts is perhaps corelated with their increased reproductive capacity. The fundatrices in their turn lay nymphs which also develop only in apterous, parthenogenetic and viviparous females known as the *Fundatrigeniæ*, without producing any males as in the former case. There are generally three generations of fundatrigeniæ while the fourth generation develops into *Migrants* which are winged, viviparous and parthenogenetic females, and here again there is no reproduction of males. The migrants seldom lay nymphs on the same host, *i.e.*, the host of their mother, and even when the nymphs are laid on the same host, they seldom develop into adults. In fact the migrants always fly to some secondary host where they lay nymphs and perhaps remain there till the end of November, and thus the migrants are responsible for their propagation. The nymphs laid by the fundatrices moult four times before they become fundatrigeniæ whose nymphs also moult four times to become migrants. In the first fortnight of March these moults are completed in eight to ten days. The adults begin to reproduce, *i.e.*, begin to lay nymphs two to three days after the last moult. During the second fortnight of February and the first fortnight of March both the fundatrigeniæ and the migrants are found in the field. Sometimes the population of the migrants becomes so high that the whole vegetation and the sky round about the mustard fields become covered with them. The migrants which are lucky enough so as to reach their suitable host similarly reproduce on their own account. The observations show that the progeny of the migrants of whatever age it may be, is unable to feed itself on mustard even though they may be young and green, therefore it may be said that the migrant stage of the aphid is not a pest of mustard.

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A detailed study of the aphid is in progress and will be presented in due course.

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A STUDY ON THE LIFE CYCLE OF *BRUCHUS ANALIS* FEB., THE COMMON PULSE BEETLE

THE life-cycle was studied under laboratory conditions at a constant temperature of 92° F. The data given below have been recorded at this temperature.

Duration of the egg stage.—The average of twenty-five cases studied was 5½ days with 5 days as the minimum and 6 days as the maximum.

Duration of the larval stage.—It is an interesting fact that the duration of this stage was very much longer when it was fed exclusively on *Cicer arietinum* than when it was fed on various species of *Phaseolus*. The undermentioned observations were recorded.

TABLE I

Grain on which larva was fed	Average larval period in days	Number of cases studied
Phaseolus mungo ..	11½	15
Phaseolus radiatus ..	11½	14
Phaseolus aconitifolius ..	11½	5
Cicer arietinum ..	17½	7

Duration of the pupal period.—The actual pupation took place about 24 hours after the formation of the lid-like exit for the adult. The following data were recorded.

TABLE II

Pupal period in days	Number of cases studied
7	3
8	11
9	7
10	1
	TOTAL 22

The average pupal period at 92° F. worked out to be $8^{3}/_{11}$ days.

The adult stage period was studied in a large number of cases. The average for the female was 9·5 days and for the male 9 days. The beetles were fed on powdered grain.

The oviposition started on the day following emergence. The male and the female that emerged on the same day were taken as a pair

TABLE III

The Rhythm and Duration in Days of Oviposition of B. analis *Fab.*

Sl. No.	Date of emergence of pair	Date of 1st egg laying	The rhythm of Egg laying on days											Total eggs laid	Last date of egg laying	Total egg laying period in day
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI			
1	4·2·1944	5·2	5	8	8	9	11	11	8	6	3	—	—	69	13·2	9
2	4·2·1944	do	6	12	16	17	15	14	10	8	2	—	—	100	do	9
3	do	do	6	8	11	11	17	12	10	5	3	—	—	83	do	9
4	do	do	6	10	12	11	20	14	6	3	—	—	—	82	12·2	8
5	5·2·1944	6·2	27	16	13	15	15	10	6	2	—	—	—	104	13·2	8
6	do	do	15	15	10	10	11	8	5	3	—	—	—	77	do	8
7	do	do	17	17	13	13	11	9	2	1	1	—	—	84	14·2	9
8	do	do	4	16	13	13	13	11	9	3	—	—	—	82	13·2	8
9	6·2·1944	8·2	—	8	8	15	10	10	10	7	—	9	2	79	16·2	9
10	do	7·2	8	9	9	17	10	13	9	6	—	—	—	81	14·2	8
												Average say 84		84·1		8·5 days

for further study. They all mated on the same day as they emerged. The pair continued to lay eggs for about 9 days. The average number of eggs laid by a pair was 84 with 69 as the minimum and 104 as the maximum. The maximum number of eggs laid by a pair on any one day was 27. The pairs continued to lay eggs for 8 to 9 days.

The rhythm of oviposition was observed in 10 pairs as detailed in Table III. Ten fresh grains of white gram were offered every day to each pair for noting the number of eggs laid on that day. The bruchid, as far as possible, made an even distribution of its quota on the grain. Mostly one, otherwise two eggs were laid on each grain.

Entomologist,
Stored Grain Pests Sec.,
Dept. of Agriculture,
Sind,
GOBIND RAM.

May 29, 1945.

OSTEOMETRIC DETERMINATION OF SEX FROM THE HEAD AND THE LOWER END OF THE FEMUR

FIGURES for osteometric determination of sex from the head of the femur and its lower end are available for English bones.[1,2] As similar figures in Indians would provide interesting records for medico-legal workers, 186 fresh, adult bones (of both sexes) were examined. Maximum and minimum diametres of the head, and maximum width of the lower end (excluding epicondyles) were recorded in millimetres. The results are given in Tables I and II.

TABLE I

Sex of bone	Diameter of the head							
	Maximum				Minimum			
	Highest		Lowest		Highest		Lowest	
	mm.	%	mm.	%	mm.	%	mm.	%
Male	56	0·6	41	5·4	51	2·7	40	8·2
Female	43	12·8	35	2·5	43	5·1	34	2·5

TABLE II

Sex of bone	Maximum diameter of the lower end			
	Highest		Lowest	
	mm.	Percentage	mm.	Percentage
Male ..	83	0·9	67	1·8
Female ..	69	7·7	59	15·3

Evaluation of these results, after allowing for sources of error, makes it possible to draw the following conclusions:—

(1) A bone with a maximum or minimum diameters of the head above 44 mm., and width of the lower end above 70 mm. is most likely to be that of a male.

(2) A bone with similar diameters below 40 mm. and 70 mm. is just as likely to be that of a female.

(3) A bone with the above diameters of the head between 40 mm. and 44 mm., and of the lower end between 66 and 70 mm., may belong to either sex. Osteometry is of no use in such cases.

As the bones for investigation, under report, were from the British Indians (Punjabis) the results would be applicable primarily to the residents of the Punjab.

M. A. SHAH.
MUBARIKA SHAH.

Department of Anatomy,
Dow Medical College,
Hyderabad (Sind),
August 31, 1945.

1. Frazer, Buchanan's *Manual of Anatomy*, 1937, 346 and 354. 2. Parson, *J. Anat. Phys.*, 1913, **14**, 253.

ON A NEW COCCIDIUM *WENYONELLA GALLINAE* N.SP., FROM THE GUT OF THE DOMESTIC FOWL, *GALLUS GALLUS DOMESTICUS* LINN.

In September 1944, a natural outbreak of coccidiosis occurred amongst four to six-week old chickens at Mukteswar. Four birds in one cage were attacked, of which three died. Another chick of about the same age died of the infection in October. The affected chickens passed blackish-green semi-solid excreta which contained numerous unsporulated oöcysts. On post-mortem examination, one of the birds showed pin-point hæmorrhages in the mucosa of the terminal part of the intestine, the wall of which was thick and congested. The gut contained a greenish fluid which abounded in oöcysts. In 2·5 per cent. solution of potassium bichromate, oöcysts took four to six days to complete their sporulation at 28° C. The tetrazoic tetrasporocystid nature of the oöcyst at once relegated this organism to the genus *Wenyonella* Hoare (1933).

Only five species of *Wenyonella* have been reported to date, *viz.*, (1) *W. africana* Hoare (*loc. cit.*) from an African snake, *Bœdon lineatus*, (2) *W. hoarei* Ray and Das Gupta (1935, 1937) from an Indian squirrel, *Sciurus* sp., (3) *W. uelensis* van den Berghe and (4) *W. parva* van den Berghe (1938) from Congolese rodents, *Funisciurus anerythrus* and *Tamiscus emini* respectively, and (5) *W. bahli* Misra (1944) from the common grey quail, *Coturnix communis*. A comparison of these species in respect of the shape and dimensions of oöcysts and sporocysts and their contents with this coccidium has convinced the author that it belongs to a new species. It has, therefore, been designated as *Wenyonella gallinæ* n. sp., the specific name being given after the generic title of the host.

Three young birds were fed with sporulated oöcysts of *W. gallinæ*. Concurrent with the passing of blackish-green semi-solid excreta, one showed unsegmented oöcysts in its fæces on the seventh day and two others on the eighth day. Thereafter, oöcyst elimination continued for three consecutive days, when the colour and consistency of the fæces returned to normal.

The life-cycle of this organism and its pathogenicity to young and old birds is being studied in detail. Since this is the first record of *Wenyonella* from chickens the author has described the oöcyst only with a view to help investigators on poultry diseases to distinguish it from members of the genus *Eimeria*.

Description of the oocyst—Oöcysts are oval or egg-shaped. The ectocyst is 1·34 to 1·5μ thick. Its surface presents a punctate appearance and in optical section, appears rugged (Figs. 1 & 2). The endocyst is thin and is interrupted at the narrow micropylar end. Size of the oöcyst varies from 29·48 μ to 33·50 μ in length and

FIG. 1

FIG. 2

Wenyouella gallinae n. sp. × 1100

FIG. 1. Surface view of a portion of eclocyst.

FIG. 2. A mature oöcyst.

19·84 μ to 22·78 μ in breadth. Sporocysts appear as short-necked round-bottomed vials. The four sporocysts occupy almost the whole space within the oöcyst. There is a hyaline plug-like structure at the neck-end of each sporocyst. Each sporocyst, measuring 18·76 μ in length and 8·04 μ in breadth, contains four club-shaped sporozoites and a granular residue. Sporulation time varies from four to six days at 28° C.

Systematic position—*Wenyonella gallinæ* n.sp. (Eimeriidea, Coccidiida).

Host—The domestic fowl, *Gallus gallus domesticus* Linn.

Habitat—Epithelium of the terminal part of the intestine.

Locality—Mukteswar, Kumaun, U.P., India.

I am indebted to Mr. J. R. Haddow of this Institute for handing me the material for study.

Imperial Veterinary Res. Institute,
Mukteswar, Kumaun, U.P., H. N. RAY.
September 12, 1945.

1. Van den Berghe, L., *Parasitology*, 1938, **30**, 275. 2. Hoare, C. A., *Ibid.*, 1933, **25**. 359. 3. Misra, P. L., *Proc. Nat. Inst. Sci., India*, 1944, **10**, 1203. 4. Ray, H. N., *Science and Cultuae*, 1935, **1**, 112. 5. Ray, H. N., and Das Gupta, *Parasitology*, 1937, **29**, 117.

REVIEWS

Advances in Nuclear Chemistry and Theoretical Organic Chemistry. Edited by R. E. Burk and Oliver Grummitt. (Interscience Publishers, Inc., New York, U.S.A.), 1945. $ 3.50.

The volume under review, the third of a series, presents the substance of a course of lectures by men of distinction in their field designed "as a mechanism for presenting to graduate students the flow of chemical research and for keeping industrial chemists abreast of their science". The forward movement of science is taking such rapid strides that keeping abreast is no easy task, especially when frontier subjects are concerned and the gap between undergraduate courses and research is one that requires to be closed by methods similar to those adopted by the Western Reserve University in the present series. One is tempted to add that the position is worse in the case of courses in some of the older Universities in this country and the task of bridging the gulf more formidable.

The volume presents five different branches and by no means can be considered to cover the full ground that may be expected by the title but within the compass of the small monograph, the ground covered has been well presented. Dr. Keston has outlined the use of isotopic tracers in the study of biochemical problems. The introductory section is followed by one on stable isotopes which gives a brief account of methods of concentration of isotopes besides a note on the Bleakney-Rittenberg mass spectrometer, a description of which is absent even from recent text-books. The last section gives a good picture of the use of both stable and radioactive isotopes in the study of animal metabolism.

Professor Taylor has given a lucid review of the use of isotopic tracers in elucidating the mechanism of heterogeneous reactions. The short contribution gives a critical account of exchange reactions involving deuterium as well as the various reduction processes. The importance of this tool in investigating technically important reactions is brought to notice in the study of the exchange reactions of nitrogen isotopes.

Dr. Crane has given the basic principles underlying the different methods adopted in nuclear physics for the production of high energy projectiles. The last section of this short contribution deals with the 'practical applications of nuclear physics' which, however, does not include the destructive use of this power that was to come!

The considerable attention that has been given to the refinement of classical structural theory of organic chemistry during the last fifteen years, naturally, leads one to expect a section on Resonance in a book of this type and the contradiction by Dr. Brooker on the subject covers the greater part of the volume. A brief survey of the application of this concept in the interpretation of molecular structures is followed by an account of the applications to a few problems in organic chemistry. As the author himself remarks, the selection of topics is somewhat arbitrary and one would certainly like a fuller treatment of even some of the topics dealt with. The longest single section is devoted to the problem of colour and constitution which has been Dr. Brooker's special field of study and the account gives a fairly good picture of the correlation between absorption and dye structure leading to a classification of dyes of the linear resonator group according to the degree of degeneracy of the extreme structures.

The last contribution is on the Hydrogen-bond by Prof. Rodebush who introduced the term about twenty years ago. All the essential points pertaining to the hydrogen-bond have been well brought out and there is besides a very useful section dealing with natural products and the synthetic substitutes in which this bond plays a large role.

The get-up and printing of the volume are attractive and considering the material presented, the price is not excessive. The book deserves a place in any good library.

S. V. ANANTAKRISHNAN.

A Class-Book of Botany (for Intermediate and Medical Students). By A. C. Dutta. Sixth Edition (revised and enlarged). (Published by Oxford University Press, Indian Branch), 1945. Pp. 464. Rs. 7-8.

Prof. Dutta's Class-Book on Intermediate Botany has been in existence since 1929 and, therefore, needs no special introduction to students and teachers. It appears from the number of editions it has passed through during the period of war as compared to pre-1939 period, that its demand for the class-room is on the increase. One of the indications is that the student prefers to have text-books with Indian examples of flora rather than those with foreign flora dealt as types. The present edition is considerably expanded, particularly regarding the illustrations in almost all the chapters. The arrangement of subject-matter under the different chapter heads remains the same as in any standard text-book of Botany, *viz.*, Morphology, Histology, Physiology, Ecology, Systematic Botany, Cryptogams, Gymnosperms, Evolution and Genetics. In any system of teaching biological sciences, the *liaison* between teacher and taught is a well and accurately illustrated text-book which takes the student into the subject gradually in simple language. This aspect has been given considerable emphasis in the edition under review.

Taking individual chapters, the one on Histology is very well written followed by the one on Physiology as the second best;

considerable expansion having been made over the former editions under the latter. The chapter of Systematic Botany is based on Bentham and Hooker's system, which is still very widely followed in every institution in this country, although the author has made attempts to briefly explain the Linnaen system and Engler's system of classification. Under the dicotyledons, the sub-classes included are Polypetalæ, Gamopetalæ and Incompletæ whereas, under the Monocolyledons, the subclasses are Uitaloideæ, Spadicifloræ and Glumifloræ. Special emphasis on the economic side of Systematic Botany would have, perhaps, enhanced the value of this chapter.

The chapter on Cryptogams might have been expanded further, particularly, under Algæ and Fungi, although the author has furnished adequate information, for in any case the discerning student always attempts to get additional knowledge from text-books usually prescribed for higher degree course. The final chapter on Evolution and Genetics may have to be considerably expanded since what the author has presented is too brief and not in keeping with the rapid advances made in this branch of botany. Indeed, this ultimate chapter terminates the book so suddenly that the undergraduate in the subject, for whom it is written, may not get any comprehensive birds's-eye-view of the significance of the part played by evolution in plant life. The book terminates with an appendix (standard questions in the different chapters) and a fairly exhaustive index. A note of appreciation of the author's difficulty in giving Bengali and Hindustani equivalents for the latinised names of plants may not be out of place. Considering the great number of languages in the country, standardization of the type attempted by the author should remain a dilemma for some time to come.

The text-book is well worth purchasing both by Intermediate students as well as the Medical students.

T. S. SADASIVAN.

Food Famine and Nutritional Diseases in Travancore (1943-1944). Surveys by K. G. Sivaswamy, K. K. Chandy and ten Doctors. (Servindia Kerala Relief Centre, R. S. Puram Post, Coimbatore, S. India), July 1945. Pp. 265, with 33 illustrations. Rs. 5.

At about the same time as the famine was raging in Bengal, there was serious food shortage in certain parts of the west-coast of India, particularly Travancore, which received much less publicity. The Servindia Kerala Relief Centre has brought out a well documented account of the famine conditions that prevailed in Travancore during 1943-44 and grateful thanks are due to the efforts if its enthusiastic Secretary and to the noble band of doctors who helped him in his survey of the situation and its tragic repercussions. Evidence has been brought forward to show that the excess of deaths over the normal was directly attributable to famine and to diseases that followed in its wake. The book is replete with data to prove that a large percentage of deaths was due to diarrhœa, dysentery, œdema and other nutritional diseases. Chronic digestive troubles, due to excessive consumption of tapioca, a predominantly starchy food with a little protein, claimed a heavy toll. A study of the reports by the doctors shows that the number of fatal cases of diarrhœa and œdema was greater in the latter half of 1943 and in the beginning of 1944. These cases decreased slightly in the latter part of 1944, presumably due to an increased purchasing power of the people and the introduction of State-wide rationing. But, there was an increase in the incidence of anæmia, scabies and peripheral neuritis during this period. The illustrations are profuse and reveal at a glance the state of health of the poor during the critical period. The book is not a mere chronicle of famine and the conditions that led to it. Constructive suggestions are offered which are both practical and timely. The last two chapters discuss the food policy of the State and its relation to vital statistics.

The book contains some pathetic revelations: "A member of the family had to wait till the other person returned who had the one piece of untorn clothing they all had between them!" (p. 8); "Only 3 per cent. of the ration cards issued were found to be fully used" (p. 9); "Poor families surviving on 930 calories per adult a day" (p. 42); "Double ration for Government servants" (p. 141), etc., etc. The authors are very critical, and justifiably too, of some of the policies persued by the Government which accentuated the famine.

One wishes that such statements as the following had been avoided: "Another chief trouble that is found in this locality (Shertellay) is the frequent colds and coughs. Some cases of night-blindness (Nyctalopia) too are found here. These people improve well on a diet rich in vitamin D." One also wishes that the "Errata" were either omitted or made to include all the numerous printing and other errors.

On the back cover of the book occurs the following statement: "The west-coast man has belied the findings of nutritional experts by surviving on an extremely ill-sufficient and ill-balanced diet though with less energy, less vitality, and deterioration in health." No nutrition expert ever said that persons will not "survive" on diets furnishing less than the optimum and, therefore, their findings cannot be belied by the west-coast man. Only the second half of the sentence belies the first half. Servindia can better serve India not by driving meek consolation from mere "survival" on miserable diets but by insisting upon good food and health as the fundamental and inalienable right of every man and woman.

The book with its poor quality of paper and printing is priced unconscionably high.

S. RANGANATHAN.

SCIENCE NOTES AND NEWS

In the current issue of *Mycologia* (Vol. 37, No 4, pp. 499-526, 1945), Raper and Alexander have described the lyophil process of preserving moulds. Cultures are first grown on a suitable medium in a petri-dish for about ten days at which time the conidial production is at its optimum. The spores that are formed are collected and added to approximately 0·25 c.c. of sterile beef serum until the resulting suspension is comparatively dense. About 0·05 c.c. of the suspension are then placed in a sterile lyophil tube made of 4-inch lengths of 6 mm. pyrex glass tubing, sealed at one end and fire-polished at the other. The tube is then plugged with cotton, excess cotton being burnt off; the remaining portion of the plug is pushed into the tube to a depth of one-half inch to prevent the cotton from being drawn up into the apparatus during evacuation.

The lyophil tubes are now attached to a manifold and are lowered into a bath of dry ice and cellosolve at -40 to $-50°$ C., so that the ends of the tubes containing the spore suspension are submerged into it. The material gets frozen in a few seconds when the evacuation by means of a vacuum pump is begun. The tubes are gradually raised to a position where the temperature at the level of the frozen suspension is about $-10°$ C. The frozen suspension which at first was glassy, becomes chalky as drying proceeds and forms into a tiny pellet. The tube is then sealed off with a Hoke gas-oxygen torch, the whole process requiring about two hours.

Tests have shown that in the desiccated form, the spores remain viable for three and a half years or more. Only moulds have been so far tested for their longevity in this form. Cultures grown from such lyophil preparations have appeared entirely typical of the strains under observation in both colony characteristics and in structural details and variation caused by long cultivation on rich nutritive media has been kept at the absolute minimum. The high penicillin yielding strains of *Penicillium notatum* or *P. chrysogenum* retained their capacity to produce at original levels. Storage of lyophil preparations is comparatively easy, quadruplicate preparations of 300 separate cultures could be placed in a tray, $14·5 \times 12·5 \times 12·5$ at 3 to 5° C., and the tubes can be sent by air mail without much cost. M.

The Twenty-first Annual General Meeting of the Geological, Mining and Metallurgical Society of India was held in Calcutta on 24th September 1945. Sir Cyril Fox, the retiring President, was in the Chair and Mr. B. M. Birla was the Chief Guest.

Sir Cyril Fox's Presidential Address had as its theme the Economic Minerals Bureau which was the most important item that received the attention of the Society during the year. He described the proposed activities of the Bureau under five heads:

(1) An office to supply accurate mineral and metal facts relating to Indian industries.

(2) A bureau for the collection of information and data relating to geological discoveries and the mining and metallurgical industries throughout the world.

(3) An agency for registering and recommending geologists, mining engineers and metallurgists to firms and Indian States.

(4) A laboratory for making chemical analyses and assays, and conducting physical tests on mineral and metallic substances.

(5) A Council or Board to control efficiently the above branches of work.

Sir Cyril stated that though there was naturally certain differences as to details, there was remarkable agreement regarding the need for an Economic Minerals Bureau, and he was of the opinion that the Bureau should be established immediately with items (3) and (4) as the chief activities. He further made the valuable suggestion that in view of the paucity of experienced workers, the Bureau should provide for training geologists, mining engineers and geo-chemists. It is hoped that this proposal will be given effect to, for at present, there is no dearth of young men with Honours or Post-Graduate degrees who will do very well if only they are given training in geological and mine surveying, prospecting, and in mining, milling, and metallurgical operations.

To carry out the programme, funds are necessary and Sir Cyril estimated that Rs. 2,00,000 would be required at an early stage for capital expenses and about Rs. 50,000 per per for running expenses. He felt convinced that with the co-operation and help of Indian industrialists it should be possible for the Society to initiate the Economic Minerals Bureau, which would be a paying concern if it was organised on proper lines. He was of opinion that it should not be a State-aided institution but that it should co-operate with any geological, mining, or scientific institution and with Government.

Mr. B. M. Birla then addressed the gathering with India's industrialisation as his main theme. Sir Cyril had during the course of his Presidential Address, stated that it was an enormous belief that India was well-endowed with minerals, with which view he did not at all agree. He said that only about 500,000 square miles of India had been geologically surveyed, and that too only superficially, and even such a survey had shown great potentialities. He diagnosed the trouble with unerring precision when he said that what is required is greater investigation to ascertain the nature and quantity of our mineral resources—an investigation which can only be undertaken by qualified geologists. He was of the opinion that unless we had an adequate increase in the number of competent geologists, a quicker

survey could not be made of our resources, and he hoped that the Society would seriously endeavour to bring about an increase in the number not only of geologists, but of mining engineers and metallurgists, for unless we have a large number of such technically qualified scientists and engineers, the industrialisation of India and the raising of the standard of living of the country cannot be achieved.

Mr. Birla uttered a note of warning against the illusion that once we have political freedom, we shall have every other kind of freedom including freedom from want. Economic progress, he said, can only result if we work hard for it taking the fullest advantage of modern methods and discarding our fatalistic outlook that everything is pre-ordained and that we ourselves can do practically nothing to alter the course of events.

Mr. Birla welcomed the proposal for the establishment of an Economic Minerals Bureau and said that such an institution can justify its existence if it is well staffed and equipped and if it functions with the highest possible efficiency. He suggested that the Bureau's activities should also include the laying down of standards, mainly metallurgical, for performance under Indian conditions. Sir Cyril had said that it should not be a State-aided institution, but Mr. Birla was of opinion that as long as the Bureau was perfectly autonomous, he saw no reason why it should not accept financial assistance from the State in view of its usefulness to the country. He concluded his address with the hope that the Geological, Mining and Metallurgical Society would play an increasingly important part in the industrialisation of India.

The Geological, Mining and Metallurgical Society of India Council for 1945-46

President: Dewan Bahadur D. D. Thacker, Managing Director, Pure Jharia Coal Co., Ltd., and Hon. Magistrate, Jharia. *Vice-Presidents*: Mr. Sushil Chandra Ghosh, Colliery Proprietor, Universal Trading Co., 33, Canning Street, Calcutta; Prof. S. K. Roy, Professor of Geology, Indian School of Mines, Dhanbad. *Joint-Secretaries*: Mr. N. N. Chatterjee, Lecturer in Geology, Calcutta University, Calcutta; Mr. S. K. Bose, Prof. of Mining and Surveying, Indian School of Mines, Dhanbad. *Treasurer*: Mr. B. N. Maitra, Lecturer in Geology, Presidency College, Calcutta. *Librarian*: Mr. S. Ray, Lecturer in Geology, Presidency College, Calcutta. *Other Members of the Council (Elected)*: Mr. G. C. Chaterji, Geologist, Geological Survey of India, 27, Chowringhee, Calcutta; Dr. A. K. Dey, Geologist, Geological Survey of India, 27, Chowringhee, Calcutta; Mr. Chand Mall, Chief Mining Engineer, The India Mica Supply Co., Ltd., Giridih; Mr. T. N. Muthuswamy, Professor of Geology, Presidency College, Madras; Dr. K. P. Rode, Chief Geologist, Rohtas Industries, Dalmianagar, Bihar; Mr. P. H. Pandya, Agent, Messrs. Kalyanji Mavji & Co.'s Group of Collieries, Industry Colliery, Jharia; Mr. M. L. Shome, Assistant Superintendent of Collieries, B.B.C.I. Ry.'s Kurasia Colliery, P.O. Chirimiri, Korea State, E.S.A.; Prof. Daya Swarup, Principal, College of Mining and Metallurgy, Benares Hindu University, Benares.

The Royal Institute of Science, Bombay, will be celebrating its Silver Jubilee in the third week of November this year. The celebrations are expected to be inaugurated by His Excellency the Governor of Bombay, on the 15th November 1945, and will continue up to the 22nd November 1945. Other activities in this connection will be publication of a Commemoration Volume, a Science Exhibition which will be open to the public for four days, and a series of popular lectures by eminent Indian scientists.

Prof. J. N. Mukherjee, D.Sc., F.N.I., C.B.E., Ghose Professor of Chemistry, University College of Science, Calcutta, has been appointed Director of the Imperial Agricultural Research Institute, New Delhi. It is understood that he will join the new post sometime in the middle of October 1945.

Dr. T. S. Wheeler has been appointed Professor of Chemistry, University College, Dublin (National University of Ireland).

Dr. K. R. Krishnaswami, D.Sc., F.R.I.C., H.E.H the Nizam of Hyderabad Assistant Professor of Mineral Chemistry, Indian Institute of Science, Bangalore, has been appointed Industrial Chemist to the Government of Bihar.

Dr. Frank Adcock, D.Sc. (Lond.), Dr. R. G. Harris, M.A., D.Sc. (Edin.), F.R.S.E., and Major B. C. Carter, M.I.Mech.E., have been appointed Professors of Metallurgy, Aeronautical Engineering and Internal Combustion Engineering respectively, at the Indian Institute of Science, Bangalore. These are senior scientific officers, and have been lent by His Majesty's Government for a period of three years.

The Government of Madras has deputed Mr. K. V. Sundaram Ayyar, Additional Government Analyst, King Institute, Guindy, to visit the laboratories in England and America for making a special study of Food Chemistry in those countries. He will be spending six months on a tour of those countries. The Government, it is understood, contemplate the formulation of a scheme for the development of Food Chemistry and the opening of research laboratories as a part of their post-war reconstruction programme.

We asknowledge with thanks the receipt of the following:—

BOOKS

X-Ray Metallography. By A. Taylor. (Chapman & Hall, London), 1945. Pp. 400. Price 36/-.

Industrial Oil and Fat Products. By Alton E. Bailey. (Interscience Publishers, New York, N.Y.), 1945. Pp. x + 735. Price 10 dollars.

A Text-Book of Heat. By G. R. Noakes. (Macmillan & Co., Ltd., London), 1945. Pp. 469. Price 10/6.

The Physical Structure of Alloys. By C. E. Beynon. (Edward Arnold & Co., Ltd., London), 1945. Pp. 126. Price 6/6.

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